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CONTENTS

†In marine separate.

CORRECTIONS

REVIEW:

March, 1924, page 180, under heading "Rivers and Floods," second paragraph, eighth line, the year "1899" should be "1889."

May, 1924, page 272, second column, 18th line from top, for "17th" read "19th" psalm.

Page 275, Table 2, first column, for "May 30," read "April 30"; for "June 7, 14, 21" read "May 7, 14, 21."

MONTHLY WEATHER REVIEW

ALFRED J. HENRY, Editor

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JULY, 1924

Closed September 3, 1924
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PUBLICATION OF SEISMOLOGICAL DATA IN THE REVIEW TO BE DISCONTINUED

Announcement is made that a bill (H. R. 8303), quoted hereunder, authorizing the Coast and Geodetic Survey to make seismological investigations and for other purposes, was introduced in the last Congress, passed by the House of Representatives on June 5, 1924, but failed of passage in the Senate because of the legislative congestion in the closing days of the session:

Be it enacted, etc., That the Coast and Geodetic Survey is hereby authorized to make investigations and reports in seismology, including such investigations as have been heretofore performed by the Weather Bureau.

The transfer as above proposed was fully discussed by the two departments concerned, both of which were agreeable to its enactment.

In view of the necessity of effecting economies in the conduct of the work of the Weather Bureau, it has been decided to discontinue, with the close of the fiscal year ending June 30, 1924, the publication of the table of Seismological Reports. Late June reports appear on pages 375–379.—*Editor.*

THE DISTRIBUTION OF THUNDERSTORMS IN THE UNITED STATES

By William H. Alexander, Meteorologist

[Weather Bureau, Columbus, Ohio, May 14, 1924]

The following paper is essentially a revision of that published in the Monthly Weather Review for July, 1915, **43**:322–340, bringing down to date especially the statistical portion, together with a complete revision of the 13 charts based on a 20-year instead of a 10-year period. Through the courtesy of certain Weather Bureau officials, some interesting notes on the characters of thunderstorms in various parts of the country also are added. For a statement of the "Methods of thunderstorm recording used by the United States Signal Service and the Weather Bureau," prepared by the Weather Bureau Library, Prof. C. F. Talman in charge, the reader is referred to the original paper in the July, 1915, Review.

The original paper contains a summary of thunderstorm data obtained at the regular Weather Bureau stations prior to 1904; a detailed statement of the data for the 10-year period, 1904–1913, inclusive; twelve monthly charts and one annual chart based on the 10-year period; and some interesting historic notes on the character of storms in general or on individual storms of unusual interest in various parts of the country. It seems unnecessary to reproduce much of the original paper or to present the statistical data for the individual stations in detail, even for the 20-year period; a summary only is sufficient. Table 1 gives, for each of the regular Weather Bureau stations for which data are available, a summary, first, of the total number of days with thunderstorms for each month for the 20-year period 1904–1923 and, second, of the average annual number computed for that period.

Thunderstorm records prior to 1904 were not made with the same uniformity and accuracy as were those subsequent to that year. For that reason it has been considered advisable to begin the record with 1904. Moreover, by so doing the great majority of Weather Bureau stations can be used. Out of the 185 stations included in Table 1, all but 7 have the full 20-year record; those having less than 20 years are indicated by proper footnotes.

Explanation of the charts.—In charting the data the total number of thunderstorm days in the 20-year period for each month have been used to obviate the necessity of using fractional values when the total number fell below 20, as they very frequently do for the northern and extreme western portions of the country. The annual chart, however, presents the average annual number rather than the total number of thunderstorm days. The term isoceraunics used on the chart is explained below.[1]

As one would expect, the two sets of charts—the one based on the 10-year period and the one based on the 20-year period—are in very close agreement in all important details; but a close comparison of the charts, month by month, will reveal a number of minor differences. The charts are self-explanatory but perhaps a few general and very brief comments may not be amiss.

During the winter months, December, January and February, the center of thunderstorm activity for the United States is in the vicinity of Vicksburg, Miss. In February however the general thunderstorm area tends to drift southeastward; note the marked secondary over Pensacola, Fla., for example. In March, the center of activity is still over the lower Mississippi Valley with the general storm area spreading rapidly northeast over the Tennessee and Ohio valleys. In April, the center appears to be in the vicinity of Shreveport, La., with the general area spreading not only northeast over a large part of the eastern States, but also north and west.

The interesting thing about the May chart is the definite appearance of the primary center over Tampa, Fla., and a strong secondary over the lower Plains States. Great thunderstorm activity now prevails over the entire eastern half of the country, except in the Canadian bor-

[1] *Terminological note by C. F. Talman.*—In 1879 W. von Bezold and C. Lang applied the name "isobront" to a line drawn on a chart connecting places at which the first thunder in a thunderstorm was heard simultaneously. The word has since become fully established in meteorological literature with a somewhat broadened meaning, being applied generically to thunderstorm isochromes, including those of first thunder, loudest thunder, beginning of rain in a thunderstorm, etc. A chart of isobronts shows the progress of a particular thunderstorm across the country.

To avoid confusion, some different name should be applied to lines of equal thunderstorm frequency, such as appear on Mr. Alexander's charts and on charts of similar character that have been drawn for other countries and for the world at large. It is suggested that the isogram of thunderstorm frequency be called an "isoceraunic line," or, briefly, an "isoceraunic."

"Isobront" and "isoceraunic" are formed from familiar Greek words, the former meaning literally "equal thunder" and the latter "equal thunder and lightning."

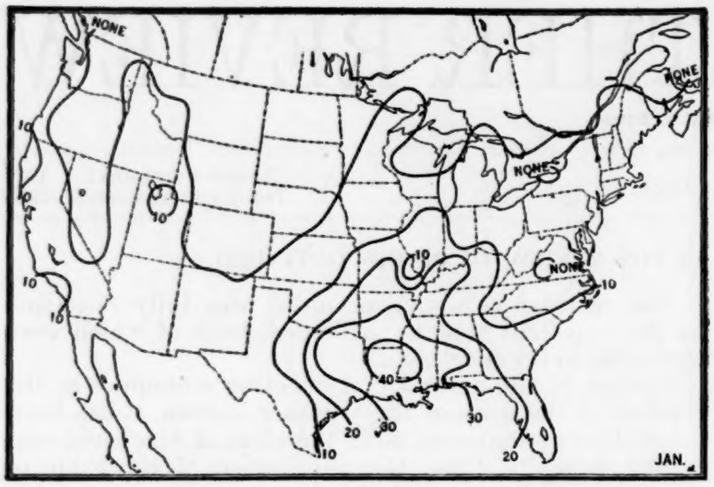


FIG. 1.—Isoceraunics, January, based upon total number of thunderstorm days, 20 years, 1904–1923

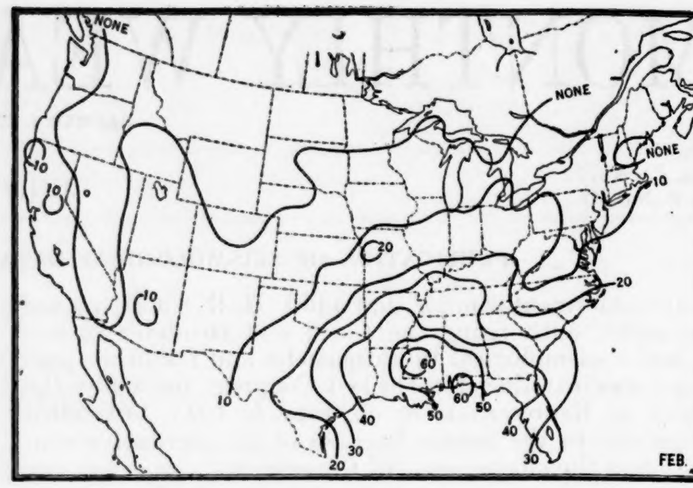


FIG. 2.—Isoceraunics, February, based upon total number of thunderstorm days, 20 years, 1904–1923

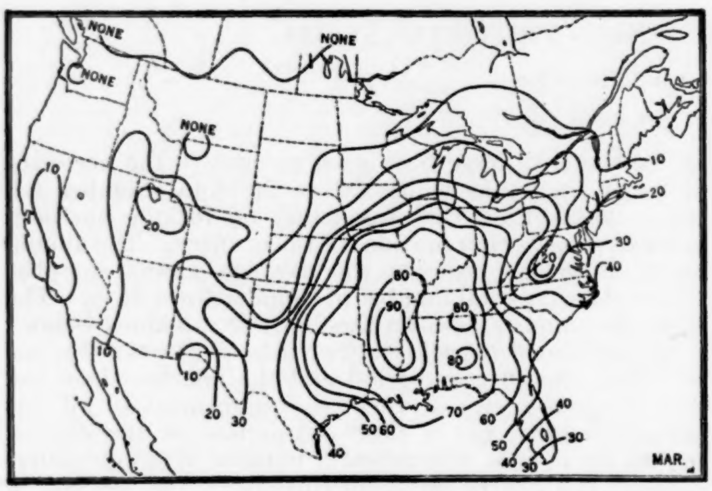


FIG. 3.—Isoceraunics, March, based upon total number of thunderstorm days, 20 years, 1904–1923

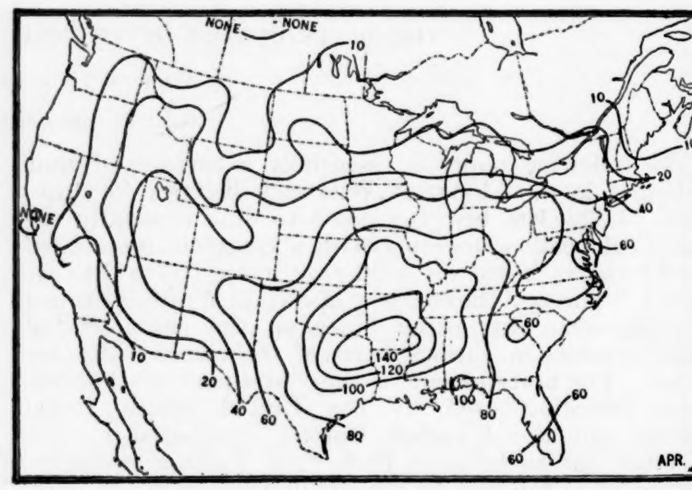


FIG. 4.—Isoceraunics, April, based upon total number of thunderstorm days, 20 years, 1904–1923

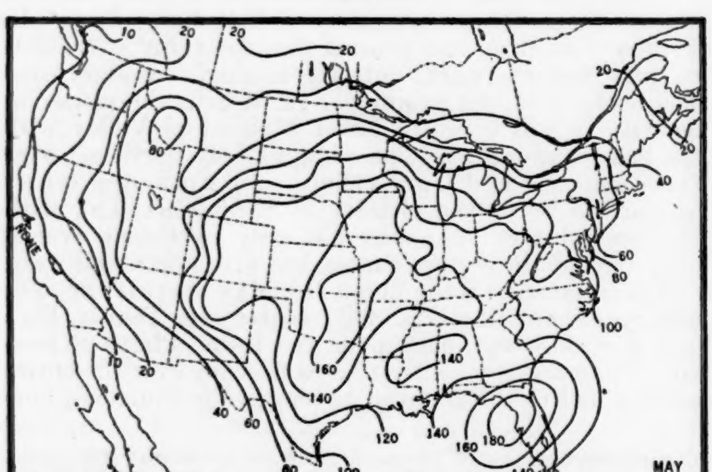


FIG. 5.—Isoceraunics, May, based upon total number of thunderstorm days, 20 years, 1904–1923

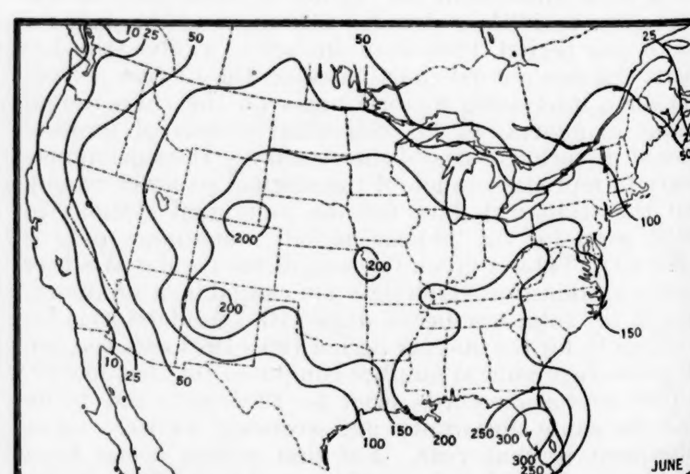


FIG. 6.—Isoceraunics, June, based upon total number of thunderstorm days, 20 years, 1904–1923

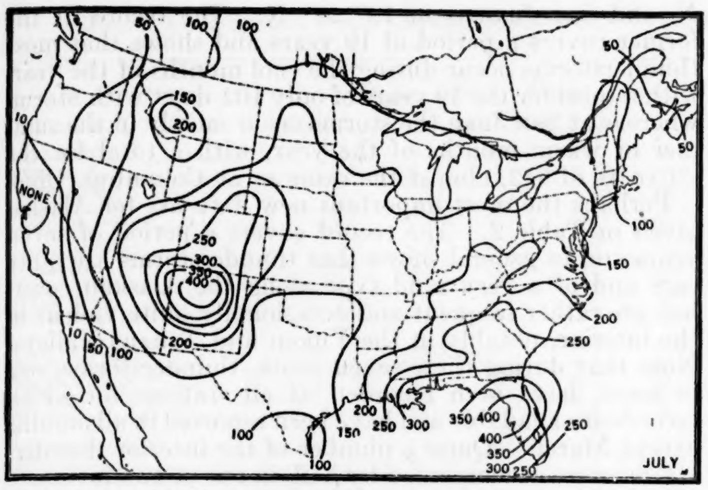


FIG. 7.—Isoceraunics, July, based upon total number of thunderstorm days, 20 years, 1904–1923

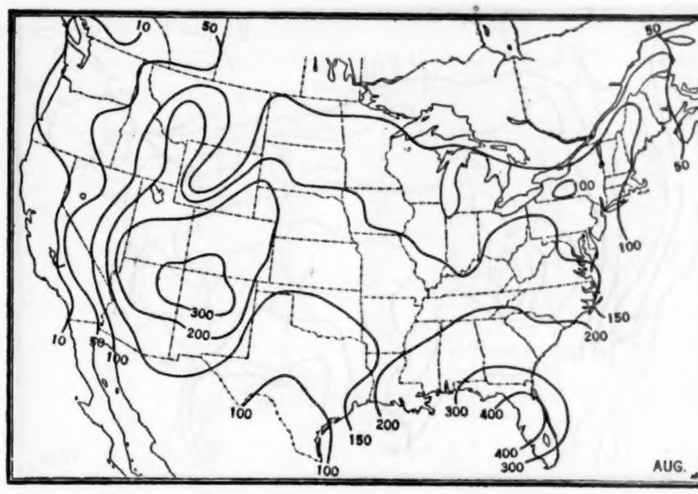


FIG. 8.—Isoceraunics, August, based upon total number of thunderstorm days, 20 years, 1904–1923

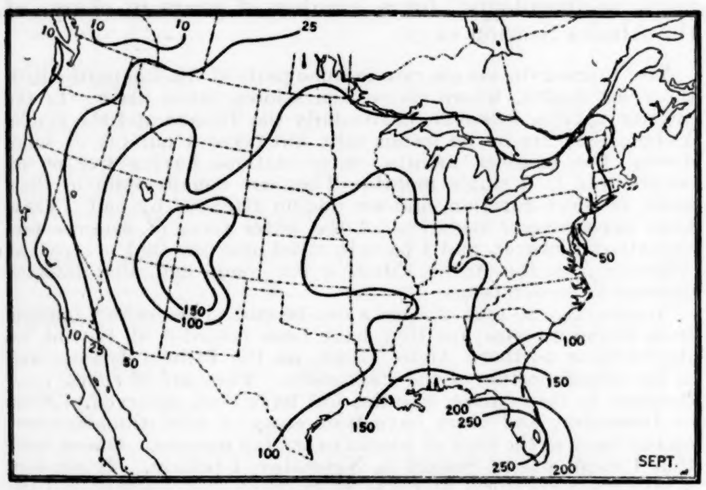


FIG. 9.—Isoceraunics, September, based upon total number of thunderstorm days, 20 years, 1904–1923

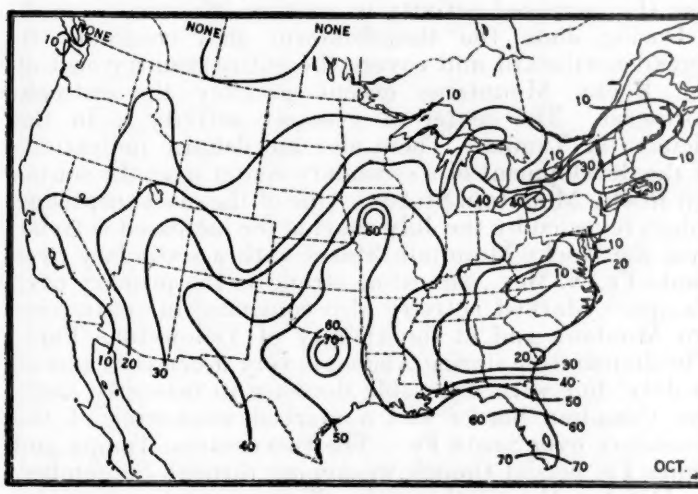


FIG. 10.—Isoceraunics, October, based upon total number of thunderstorm days, 20 years, 1904–1923

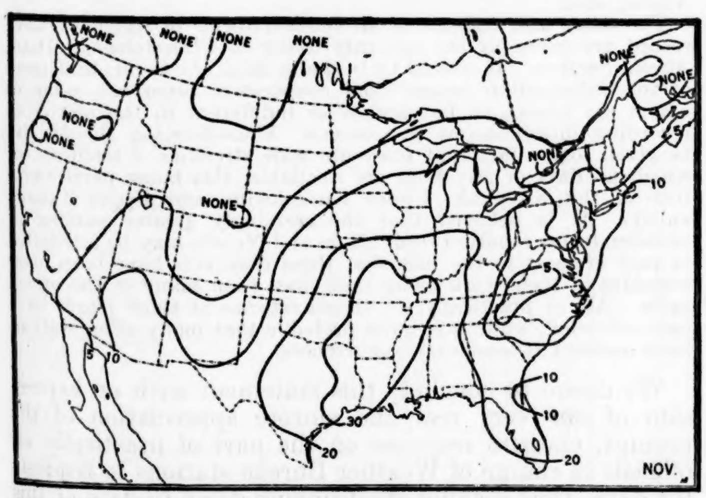


FIG. 11.—Isoceraunics, November, based upon total number of thunderstorm days, 20 years, 1904–1923

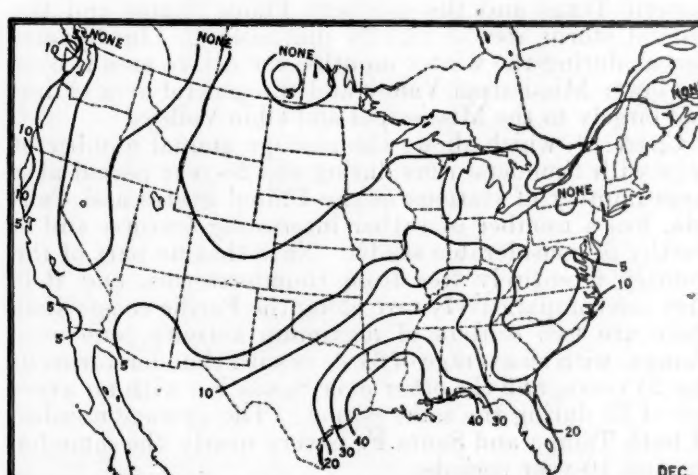


FIG. 12.—Isoceraunics, December, based upon total number of thunderstorm days, 20 years, 1904–1923

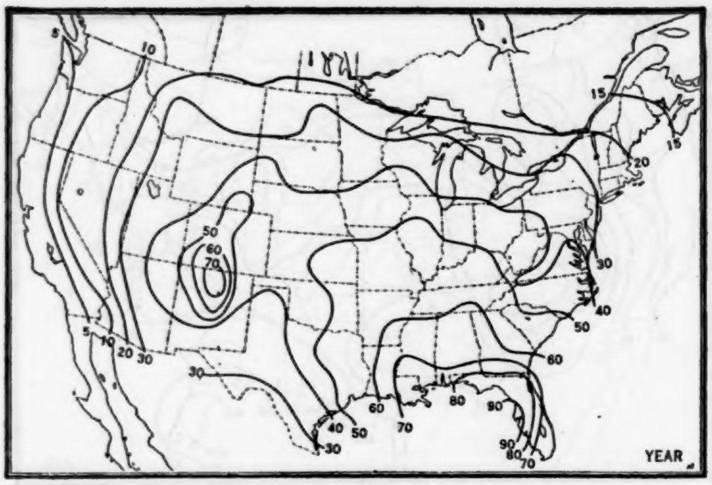


FIG. 13.—Isoceraunics, year based on average number of thunderstorm days, 20 years; 1904–1923

der states including the whole of New England. Note also the increased activity in western Montana.

During June the thunderstorm area continues to spread northward and covers the entire country east of the Rocky Mountains except possibly the extreme northeast. The center of greatest activity is in the vicinity of Tampa. There also are definite indications of the development of a secondary center over the southern Rocky Mountain States. One of the most surprising things revealed by the July chart is the increased activity over the Rocky Mountain States with a secondary over Sante Fe, N. Mex., almost as strong as the primary over Tampa. Marked activity also continues in southwestern Montana and in the vicinity of Yellowstone Park. The distribution during August is very much the same as in July, but with a notable decrease in intensity along the Canadian border and a marked weakening of the secondary over Santa Fe. The two centers, Tampa and Santa Fe, persist though weakening through September. In October the southeastern (Tampa) center seems to have dropped a little south and is now over Key West, while the Santa Fe center has disappeared or shifted to eastern Texas and the southern Plains States and the general storm area is rapidly diminishing. In November, as during the winter months, the active area is over the lower Mississippi Valley and the general area is limited largely to the Mississippi and Ohio Valleys.

Chart 13, which shows the average annual number of days with thunderstorms during the 20-year period at a large number of stations in the United States and Canada, has a number of rather interesting features and is worthy of considerable study. Note that no part of the country is entirely free from thunderstorms, and that they are comparatively rare along the Pacific coast; that there are two centers of maximum activity, one over Tampa, with an average of 94 days with thunderstorms in the 20 years, and the other over Santa Fe, with an average of 73 during the same period. The average number at both Tampa and Santa Fe is very nearly the same for the two 10-year periods.

An interesting comparative study which does not appear at all on the charts may be found in noting the records for Honolulu, Hawaii, and San Juan, P. R., two insular tropical stations. Honolulu is in latitude 21° 19′ N. and San Juan is in 18° 29′ N. The record at the former covers a period of 19 years and shows that most thunderstorms occur during the cool months of the year, with a total for the 19 years of only 102 days with storm, whereas at San Juan the storms occur mostly in the summer or warm months of the year, with a total for the 20 years of 942, almost the same as at Columbus, Ohio.

Perhaps the most important new data are for Alaska, given in Table 2. The record covers a period of seven years and in general shows that thunderstorms are quite rare and of a very mild type along the Alaskan coast, but are rather frequent and occasionally quite violent in the interior, notably in the Yukon and Tanana Valleys. Note that during these seven years, thunderstorms, one or more, have been recorded at all stations for which records are available and have been reported in all months except March. Quite a number of the interior thunderstorms were accompanied by hail, in one or two instances of a destructive character. Even damage from lightning stroke was noted.

Concerning thunderstorms in Alaska Mr. M. B. Summers, meteorologist, for a number of years in charge of the Alaska Section says:

> Yes, thunderstorms are rare in some parts of Alaska, particularly the coast region, where convection seldom takes place. In the interior valleys, however, particularly the Tanana and the middle Yukon, they are by no means rare, but occur a number of times during the summer months, some stations having five or six occurrences in a single month. They are usually mild in character, of short duration, and are seldom attended by hail. There have been several instances of the latter form of summer precipitation, however, and I have in mind now one that occurred at Allakaket, on the Arctic Circle, a few years ago, that inflicted damage to garden crops.
>
> Apparently, no part of Alaska can be said to be entirely immune from thunderstorms, for they have been recorded at Barrow, on the extreme northern Arctic Coast, on the Pribilof Islands, and in the island portion of the Panhandle. They are of course most frequent in the summer months, but have been observed at Sitka in December, and there have been cases of mild thunderstorms on the coast of the Gulf of Alaska in the fall months. One of these that I recall was at Seward in November, I believe. It attended a blinding snowstorm and was so unusual that I questioned the observer specially concerning it. Having experienced such a unique type of thunderstorm on the Pittsburg station some years ago, it afforded me considerable interest to know it may occur in Alaska, also.
>
> The dates and stations of all thunderstorms of which we have record are given in the monthly issues of Climatological Data, Alaska Section. It should be borne in mind, however, that most of the information comes from cooperative observers, some of whom are known to be careless or indifferent in the matter of recording miscellaneous phenomena. Consideration should also be given to the fact that there are wide stretches of territory for which no data of any kind are available, this being particularly true of the Koyukuk, Upper Kuskokwim, and Upper Tanana valleys. It is believed that the seemingly greater number of thunderstorms reported from Eagle and Nulato may be attributed in part at least to the fact that these observers have been more watchful in their work along such lines than many of the others have. All, or practically all, thunderstorms at those places have been recorded, while it is quite probable that many other stations have omitted at least some occurrences.

We desire to conclude this statement with an expression of our very real and sincere appreciation of the prompt, cheerful response on the part of practically all officials in charge of Weather Bureau stations to requests for data, thus making the bringing-down-to-date of this paper possible. Quite a number evidently put them selves to considerable trouble and labor to supply even more data than the "form" called for.

TABLE 1.—*Days with thunderstorms at Weather Bureau stations in the United States for the 20-year period 1904–1923, inclusive*

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Average annual
Abilene, Tex	14	14	44	95	144	119	110	114	62	52	24	13	40
Albany, N. Y	2	2	17	30	71	113	143	105	52	18	8	3	28
Alpena, Mich	1	0	24	38	80	113	125	103	69	21	10	3	29
Amarillo, Tex	5	4	17	67	114	130	143	143	88	38	8	2	38
Anniston, Ala. (a)	19	45	75	92	144	237	277	235	120	27	17	22	73
Asheville, N. C	4	16	44	75	139	258	265	221	95	15	4	3	57
Atlanta, Ga	11	29	68	78	137	207	292	237	98	16	15	12	60
Atlantic City	2	9	25	51	63	121	123	111	45	23	8	4	29
Augusta, Ga	14	27	55	58	106	179	253	208	84	25	13	7	51
Baker, Oreg	0	0	2	12	36	71	81	67	31	6	0	0	15
Baltimore, Md	3	9	29	54	89	131	177	126	55	12	1	4	34
Bentonville, Ark. (b)	25	31	79	113	167	195	144	142	99	61	38	20	66
Binghamton, N. Y	2	7	24	31	78	124	168	120	65	23	5	1	32
Birmingham, Ala	26	38	74	101	146	240	290	239	138	27	21	24	68
Bismarck, N. Dak	0	0	1	21	77	142	159	130	63	16	1	0	30
Block Island, R. I	1	7	22	32	41	63	68	73	33	17	8	2	18
Boise, Idaho	3	4	16	26	66	81	74	59	39	13	2	4	19
Boston, Mass	2	2	19	18	43	67	93	76	41	11	2	3	19
Buffalo, N. Y	2	9	29	38	93	121	140	121	70	31	10	2	33
Burlington, Vt. (a)	2	1	12	23	61	107	136	110	59	23	1	1	30
Cairo, Ill	29	36	80	117	157	212	198	175	115	34	38	18	60
Canton, N. Y. (b)	2	4	16	25	51	69	107	93	50	21	2	0	26
Cape Henry, Va	3	14	40	67	129	173	191	156	70	22	6	8	44
Cape May, N. J	4	12	24	50	56	113	130	101	43	10	8	1	28
Charleston, S. C	13	38	48	73	127	175	274	243	132	27	14	10	59
Charlotte, N. C	6	19	44	69	112	186	238	187	73	17	9	4	48
Chattanooga, Tenn	16	29	84	90	141	245	247	242	118	19	20	11	63
Cheyenne, Wyo	0	0	2	51	148	229	273	250	100	13	0	0	53
Chicago, Ill	10	10	54	63	111	152	133	135	96	34	14	1	41
Cincinnati, Ohio	13	13	62	80	141	180	212	158	91	37	15	8	50
Cleveland, Ohio	5	10	35	64	107	126	156	120	88	34	10	2	38
Columbia, Mo	23	13	70	114	176	193	174	193	135	42	35	11	59
Columbia, S. C	11	25	51	78	120	197	243	212	96	19	7	10	53
Columbus, Ohio	9	17	59	77	123	187	198	152	86	25	19	4	48
Concord, N. H	2	0	9	14	46	71	119	108	40	11	4	2	21
Concordia, Kans	1	7	30	64	121	175	162	152	104	31	12	2	43
Corpus Christi, Tex	10	19	35	64	108	64	88	82	111	44	20	18	33
Davenport, Iowa	5	7	45	66	135	162	151	146	117	32	15	5	44
Dallas, Tex. (c)	26	26	44	78	77	80	55	70	40	32	19	17	56
Del Rio, Tex. (a)	8	6	22	47	46	47	41	40	28	20	11	4	18
Denver, Colo	0	0	12	35	124	199	251	238	100	15	1	0	49
Des Moines, Iowa	2	7	39	78	157	185	166	147	118	60	14	2	49
Detroit, Mich	6	13	35	68	98	148	144	129	78	35	11	2	38
Devils Lake, N. Dak. (d)	0	0	2	16	61	142	155	134	61	10	2	0	31
Dodge City, Kans	3	1	17	55	122	184	172	154	84	31	12	2	42
Dubuque, Iowa	2	5	36	70	128	157	136	133	100	40	14	2	41
Duluth, Minn	2	0	8	18	80	127	148	117	67	17	5	0	29
Eastport, Me	3	2	6	8	31	60	92	64	25	20	4	1	16
Elkins, W. Va	1	15	39	70	123	203	215	146	83	23	8	4	46
El Paso, Tex	4	6	9	18	32	100	177	188	74	35	10	5	33
Erie, Pa	5	10	36	64	101	142	128	123	83	47	9	5	38
Escanaba, Mich	0	2	21	32	67	122	158	123	81	29	9	1	32
Eureka, Calif	13	10	8	2	2	2	2	3	4	7	8	16	4
Evansville, Ind	22	24	77	98	147	189	188	172	106	40	30	18	56
Fort Smith, Ark	27	31	77	123	175	186	139	154	92	53	30	18	55
Fort Worth, Tex	33	39	75	137	174	154	130	136	94	71	30	19	55
Fresno, Calif	1	7	10	16	17	6	5	4	10	8	2	4	4
Galveston, Tex	22	40	47	85	112	102	160	172	135	58	31	44	50
Grand Haven, Mich	4	7	35	50	99	113	117	113	75	29	16	3	33
Grand Junction, Colo	0	3	19	48	76	112	240	221	113	30	3	2	43
Grand Rapids, Mich	3	8	39	61	103	131	131	117	90	40	17	4	37
Green Bay, Wis	0	3	21	37	94	123	142	120	84	29	10	1	33
Hannibal, Mo	14	11	70	92	151	175	146	157	117	41	25	8	50
Harrisburg, Pa	2	8	16	50	89	153	185	142	59	27	3	2	37
Hartford, Conn. (d)	5	6	24	29	59	82	140	113	52	27	6	3	29
Hatteras, N. C	15	26	44	62	94	113	152	133	75	20	15	12	38
Havre, Mont	0	0	2	13	41	158	141	105	33	1	0	0	25
Helena, Mont	2	0	4	23	86	185	201	163	48	8	2	1	36
Houghton, Mich	0	2	17	22	57	93	100	84	70	21	7	0	24
Houston, Tex. (e)	14	27	43	59	86	93	142	155	80	44	25	38	58
Huron, S. Dak	0	2	12	32	107	171	170	148	83	19	5	0	37
Independence, Calif	0	0	1	8	19	24	84	69	19	12	1	0	12
Indianapolis, Ind	8	10	65	93	123	178	183	147	105	35	28	6	49
Iola, Kans. (a)	13	13	51	89	150	157	139	130	113	43	18	6	51
Ithaca, N. Y	2	3	15	33	79	121	155	100	64	29	5	0	30
Jacksonville, Fla	17	44	57	77	172	259	385	340	171	46	9	20	80
Jupiter, Fla. (g)	3	13	29	35	77	118	150	142	81	[illegible]	8	8	65
Kalispell, Mont	0	0	1	9	41	89	113	81	26	8	1	0	18
Kansas City, Mo	13	21	77	109	158	206	190	177	142	59	23	5	59
Keokuk, Iowa	9	13	62	81	157	175	160	167	115	49	21	4	51
Key West, Fla	18	23	25	48	101	175	227	243	227	74	24	29	61
Knoxville, Tenn	9	25	57	93	136	203	214	185	90	12	15	11	52
La Crosse, Wis	1	2	21	54	149	176	155	148	113	35	11	1	43
Lander, Wyo	0	0	1	13	51	103	105	94	40	3	1	0	21
Lansing, Mich. (f)	0	6	25	43	73	96	97	100	71	19	8	1	41
Lewiston, Idaho	1	0	7	17	40	67	76	52	30	11	1	0	15
Lexington, Ky	17	25	59	89	133	197	221	169	105	20	17	11	53
Lincoln, Nebr	2	7	22	75	132	196	182	172	123	42	11	2	48
Little Rock, Ark	31	46	95	143	126	195	179	170	102	40	34	25	59
Los Angeles, Calif	10	7	16	7	4	4	4	6	9	6	5	2	4
Louisville, Ky	24	24	78	95	123	186	198	145	95	28	29	12	52
Lynchburg, Va	0	4	19	46	82	167	173	131	55	9	4	2	35
Macon, Ga	16	41	67	76	137	204	276	235	90	26	11	9	59
Madison, Wis. (d)	2	4	32	68	137	155	158	141	97	25	11	1	44
Marquette, Mich	0	0	17	17	59	110	121	97	53	15	6	0	25

TABLE 1.—*Days with thunderstorms at Weather Bureau stations in the United States for the 20-year period 1904–1923, inclusive*—Continued

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Average annual
Memphis, Tenn	26	38	78	109	118	165	185	159	86	33	31	26	53
Meridian, Miss	34	53	76	119	140	213	247	218	104	31	23	39	65
Miles City, Mont	0	0	1	8	57	149	122	87	21	6	1	0	23
Milwaukee, Wis	5	3	34	57	114	144	109	133	100	30	11	1	37
Minneapolis, Minn	1	2	14	32	114	163	146	142	90	33	8	0	37
Mobile, Ala	24	54	74	96	139	228	323	282	155	37	23	35	74
Modena, Utah	3	1	11	41	71	59	234	233	78	24	8	2	38
Montgomery, Ala	32	56	87	90	139	207	231	220	107	26	28	23	62
Moorehead, Minn	0	0	6	19	87	136	143	117	66	16	2	0	30
Mount Tamalpais, Calif. (b)	6	3	4	1	0	1	1	1	7	1	2	5	2
Nantucket, Mass	6	10	19	32	46	73	75	65	34	30	15	8	21
Narragansett Pier, R. I. (e)	2	6	7	17	29	39	56	54	20	9	7	1	18
Nashville, Tenn	18	33	77	105	148	200	219	176	104	31	22	22	58
New Haven, Conn	4	4	22	29	62	111	133	109	51	23	7	3	28
New Orleans, La	38	46	76	93	134	227	302	298	163	46	22	44	74
New York, N. Y	4	4	19	46	79	116	150	113	51	23	4	3	31
Norfolk, Va	3	17	28	51	115	153	187	152	55	18	7	6	40
Northfield, Vt	1	1	6	16	57	97	143	107	66	22	2	2	26
North Head, Wash	2	4	3	0	1	2	5	6	4	7	8	8	2
North Platte, Nebr	0	1	9	46	132	187	204	181	66	14	5	0	42
Oklahoma, Okla	13	19	69	103	148	178	121	132	95	58	25	6	48
Omaha, Nebr	1	6	27	77	150	189	170	174	121	48	13	2	49
Oswego, N. Y	3	9	26	26	78	110	119	105	58	31	5	3	29
Palestine, Tex	33	42	75	144	152	139	150	130	95	56	28	37	54
Parkersburg, W. Va	4	18	46	76	129	201	193	155	80	25	11	5	47
Pensacola, Fla	32	64	71	100	157	233	329	320	192	55	23	43	81
Peoria, Ill. (d)	10	9	64	95	156	185	152	149	108	35	18	6	52
Philadelphia, Pa	2	11	23	45	83	125	167	125	47	22	5	2	33
Phoenix, Ariz	5	11	19	22	22	27	189	196	63	23	17	6	30
Pierre, S. Dak	0	1	3	20	98	154	166	136	58	14	2	0	33
Pittsburgh, Pa	9	14	43	72	117	179	191	160	95	29	8	5	46
Pocatello, Idaho	5	2	9	40	78	105	147	146	81	17	3	1	32
Point Reyes, Calif	9	7	4	1	0	1	1	3	6	4	4	5	2
Port Huron, Mich	3	11	28	49	90	127	131	126	72	30	8	2	34
Portland, Me	1	0	8	8	27	56	87	71	30	16	3	4	16
Portland, Oreg	2	3	3	7	17	17	14	17	17	9	2	1	5
Providence, R. I. (d)	1	5	15	21	44	60	82	79	39	12	5	2	19
Pueblo, Colo	0	3	9	43	122	178	274	223	81	16	3	2	48
Raleigh, N. C	6	17	40	58	119	175	220	159	74	17	7	2	45
Rapid City, S. Dak	0	0	5	26	107	216	219	174	60	12	2	0	41
Red Bluff, Calif	4	5	12	8	20	14	5	3	7	8	1	4	5
Reno, Nev. (a)	0	1	1	6	36	49	82	51	31	7	0	0	15
Richmond, Va	3	8	36	67	114	170	193	157	70	11	5	2	42
Rochester, N. Y	0	5	25	38	78	113	155	122	64	20	3	2	31
Roseburg, Oreg	0	0	4	4	17	15	15	13	11	2	0	1	4
Roswell, N. Mex. (a)	1	6	19	54	82	132	152	155	82	39	7	0	38
Sacramento, Calif	6	11	13	7	5	3	0	3	9	11	3	2	4
St. Joseph, Mo. (c)	2	7	39	61	98	122	109	113	96	29	12	3	49
St. Louis, Mo	9	19	70	97	137	163	158	160	109	49	26	4	50
St. Paul, Minn	0	2	15	27	107	155	137	125	83	27	6	1	34
Salt Lake City, Utah	11	7	25	43	79	96	144	167	86	29	8	2	35
San Antonio, Tex	9	24	49	99	130	81	102	82	89	46	27	18	38
San Diego, Calif	7	2	4	2	5	5	9	10	6	7	4	6	3
Sand Key, Fla. (g)	19	17	22	44	60	85	122	137	121	50	15	25	65
Sandusky, Ohio	7	11	38	57	123	148	153	132	86	32	10	3	40
San Francisco, Calif	5	7	2	0	1	1	0	4	3	4	1	3	2
San Jose, Calif. (a)	2	3	0	2	0	1	0	3	4	2	1	4	1
San Luis Obispo, Calif	3	3	9	3	5	2	3	5	11	9	4	4	3
Santa Fe, N. Mex	5	8	30	61	137	223	417	355	162	49	8	1	73
Sault Ste. Marie, Mich	1	0	16	23	45	75	77	81	64	33	10	0	21
Savannah, Ga	13	32	41	73	132	200	297	253	120	20	11	7	60
Scranton, Pa	1	2	18	35	81	144	161	125	63	28	5	1	33
Seattle, Wash	1	2	7	6	14	25	19	17	11	9	3	1	6
Sheridan, Wyo. (f)	0	0	0	13	82	176	169	115	39	3	0	0	35
Shreveport, La	40	46	77	147	133	144	162	145	75	31	32	36	53
Sioux City, Iowa	1	2	10	54	129	189	172	162	100	32	11	2	43
Spokane, Wash	2	0	1	13	22	47	45	47	18	5	0	0	10
Springfield, Ill	13	13	77	93	150	176	164	145	105	41	27	7	51
Springfield, Mo	23	20	70	106	150	198	175	149	103	45	35	10	55
Syracuse, N. Y	3	5	20	36	89	133	152	130	70	32	4	1	34
Tacoma, Wash	2	3	0	7	11	17	20	19	10	4	5	0	5
Tampa, Fla	21	31	43	64	184	317	440	430	256	65	11	21	94
Tatoosh Island, Wash	11	3	2	4	1	4	13	6	10	15	14	10	5
Taylor, Tex	24	33	67	114	145	95	112	114	94	55	29	29	46
Thomasville, Ga. (a)	22	47	58	86	143	246	330	279	150	34	16	16	79
Toledo, Ohio	7	12	35	75	111	161	165	137	85	37	16	2	42
Tonopah, Nev. (f)	0	2	1	10	23	29	66	57	28	5	0	0	13
Topeka, Kans	8	8	54	90	143	174	175	164	143	51	29	4	52
Valentine, Nebr	0	0	8	33	114	173	184	168	75	14	5	0	39
Vicksburg, Miss	47	68	98	135	147	216	233	217	122	48	33	46	70
Wagon Wheel Gap, Colo. (f)	0	1	4	26	64	160	255	254	102	27	5	1	69
Walla Walla, Wash	0	0	4	15	28	49	50	38	22	5	1	0	11
Washington, D. C	5	10	32	65	94	153	187	136	78	17	9	6	40
Wichita, Kans	8	14	50	95	161	184	170	154	124	50	20	4	52
Williston, N. Dak	0	0	1	11	48	146	129	111	39	5	0	0	24
Wilmington, N. C	11	26	43	75	105	169	235	212	97	20	7	7	50
Winnemucca, Nev	0	0	8	11	44	56	57	48	32	8	1	0	13
Wytheville, Va	3	5	31	49	102	171	161	135	65	9	2	2	37
Yankton, S. Dak	0	1	14	49	132	175	189	159	84	24	8	0	42
Yellowstone Park, Wyo	0	0	0	11	68	145	199	178	71	9	2	0	34
Yuma, Ariz	2	0	6	2	2	4	37	50	25	6	5	2	7
Honolulu, Hawaii (a)	24	11	12	3	7	1	0	1	4	11	6	22	5
San Juan, P. R	3	4	7	23	86	134	130	130	195	162	54	14	47

NOTE.—(a) = 18 years' record; (b) = 17 years' record; (c) = 10 years' record; (d) = 19 years' record; (e) = 14 years' record; (f) = 13 years' record; (g) = 11 years' record.

TABLE 2.—*Total number of days with thunderstorms in each month for the seven-year period, 1917–1923, inclusive, at the following stations in Alaska*

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Akiak						4		1					5
Akulurak						1	3		1				5
Allakaket						[a] 5	2	5					12
Anchorage						2	1						3
Annex Creek								2					2
Aniak								1					1
Attu	([b])												
Barrow							[a] 1	1					2
Calder											1		1
Camp No. 6									1				1
Candle						3		1					4
Chickaloon							1						1
Chicken						1	3						4
Chitina				1		1	1						3
Claim No. 2						1	1	1					3
Copper Center							1						1
Cordova									4				4
Council								1					1
Crooked Creek						1	3	1					5
Dawson						4	3						7
Dillingham							2						2
Eagle						[a] 15	9	2	1				27
Fairbanks					2	2	2	4					10
Fortman Hatchery						1		1					2
Fort Yukon						4							4
Goodnews Bay							1						1
Healy						2	3						5
Holy cross						3	2	1					6
Hydaburg				1									1
Indian River							1	1					2
Igloo								1					1
Juneau								1	1				2
Kake						1							1
Katalla										5	1		6
Kennecott							2						2
Matanuska						1							1
McKinley Park					1								1
Nakat					1								1
Naknek							1						1
Nenana						2	2	3					7
Nome						1		1					2
Noorvck					1	6	2	2					11
Nulato					3	3	5	4					15
Paxson							1						1
Peril Strait									1				1
Rampart					[a] 1	5	5	2					13
Richardson					2	1							3
Ruby							[a c] 1						1
Salcha						1							1
Salmon River					2	2	[a] 1	1					6
Seldovia							1						1
Seward		1						1	1	1	[d] 2		6
Sitka	1								3			1	5
St. Paul Island								1	1				2
Talkeetna						2	1	4	3				10
Tanana					1	7	3	3	2				16
Valdez							1	1	1				3
Total	1	1	0	2	14	82	66	48	20	6	4	1	245

[a] One or more storms accompanied by hail.
[b] Lightning observed on Jan, 28, 1921.
[c] Buildings were struck by lightning on July 3, 1920.
[d] One of these storms (that of Nov. 7, 1918) was accompanied by "a blindingstorm."

THUNDERSTORMS IN OHIO DURING 1917[2]

By W. H. ALEXANDER, C. F. BROOKS, and G. H. BURNHAM

INTRODUCTION

The purposes of this study are—

to determine as far as possible the origin, the distribution, the number, the frequency, the extent, the attending phenomena, etc., of these storms, and, if possible, to trace the history of each individual thunderstorm that enters or originates in the State of Ohio during the year 1917.[3]

About 830 well-scattered observers were enlisted. The network, however, was too open in the rougher plateau of the southeastern half of Ohio. Each observer was instructed to report each occasion thunder was heard or distant lightning seen and to give, so far as possible, the times, occurrences, or other information desired, as follows:

Thunder—first, loudest, last, and frequency; movement of storm—direction from which it appeared to come, how it passed (whether overhead, or to either side), and the direction to which it went; rain or snow—beginning, ending, and amount; hail—beginning, ending, amount, size, and form; wind—direction before and after, direction and time of highest wind; heat lightning—direction, and time. Remarks were also asked for.

Most of the observers made careful returns, but irregularity in reporting, omissions of place names or the sort of time used, and failure to discriminate between neighboring storms greatly reduced the potential value of many. The times of first and last thunder, occurrences of hail and lightning strokes, were mapped first, then small maps were made for thunderstorm areas each day or half day. Later, all the data on the cards were transferred to large post office maps.

Only on 7 days were the storms general over the State, and on 11 over almost the whole State; on 23, half the State, or slightly more, was covered; and on 17, almost half. Thunderstorms occurred with considerable frequency in a winter of much zero weather, even at times when the surface temperature was near freezing. There were tornadoes in winter as well as in summer.

Quick, decided changes in the weather proved favorable for the genesis and growth of thunderstorms, while equable conditions and gradual changes were unfavor-

[2] A joint study by the United States Weather Bureau and Clark University, in which Alexander, with the aid of H. H. Martin, collected and partially mapped the data, and both Alexander and Brooks studied them. Detailed discussions with maps are on file at the United States Weather Bureau Library, Washington, D. C., and the Columbus, Ohio, office of the Weather Bureau. The original reports and maps are at Columbus. The following summary was prepared by Brooks, of Clark University.
[3] Alexander, W. H., Climat'l. Data, Ohio Sec., Dec., 1916, 21: 91.

able. Of the 37 instances of the passage of the squall-lines of Alberta lows considered, 35 produced thunderstorms in Ohio. The openness of Ohio both to warm, moist winds and to cold winds provides the opportunity for frequent overturnings sufficiently intense for making thunderstorms.

Thunderstorms relative to pressure systems.—The distribution of thunderstorms in time and space is merely an index to the distribution of conditions favoring the violent convection of large masses of warm, humid air.[4] Thunderstorms may be classified according to their mode of occurrence. Doctor Humphreys has suggested the following divisions:[5]

Thunderstorms produced in—

"*a.* Regions of high temperature and widely extended, nearly uniform pressure. [Commonly called 'local' or 'heat' thunderstorms.]

"*b.* The southeast quadrant, or less frequently, the southwest, of a regularly formed low, or typical cyclonic storm. [Commonly known as the 'cyclonic' thunderstorm.]

"*c.* The barometric valley between the branches of a distorted or V-shaped cyclonic isobar. . . . 'tornadic.'

"*d.* The region covered by low-pressure trough between adjacent high pressure areas . . . might be called the '*anticyclonic*' thunderstorm, or even the 'trough' storm.

"*e.* The boundary between warm and cold waves . . . one might call it the 'border' storm.

In attempting to apply this classification to the 165 morning weather maps of the days with thunderstorms in Ohio during 1917 a modification was found desirable. Humphreys's classes *c* and *d* are so nearly alike that no distinction was practicable. On only four days might it seem desirable to distinguish intense thunderstorms in a distorted, sharp trough or V from the ordinary trough type. On the other hand, a rather distinct occurrence of thunderstorms was noted toward the southeastern ends of some strong "steering lines", that is, on the eastern border of the southeastern quadrant of Lows. While such storms might be classified in Humphreys's group *b*, they are different in position from the usual "cyclonic" thunderstorms in that they mark the eastern boundary of a warm, moist wind rather than the western portion, as is usually the case with thunderstorms in cyclones. Consequently, these steering-line, or warm-front storms were kept distinct from the cyclonic.

In Table I, then, the thunderstorms were classified according to Humphreys's groups, except that the "trough" and "tornadic" (*c* and *d*) were merged, and warm-front storms separated from other "cyclonic" or SE. quadrant ones. For clarity Humphreys's "trough" and "tornadic" storms (*c* and *d*) are here designated as "N.-S. trough" and his "border" type (*e*) as "E.-W. trough," the two being distinguished by whether the axis of the trough was more N.-S. or E.-W. Though the processes forming thunderstorms in both types of trough are essentially the same, the results with respect to any place are quite different. The N.-S. troughs march across the country eastward and soon pass, but the E.-W. ones in their eastward progress merely bring a continuation of thunderstorms day and night to a locality in the trough.

Table I shows the natural summer-time preponderance of thunderstorms of all classes, especially of the local and cyclonic types. The N.-S. trough storms occurred almost as often in the colder months as in the warmer. The greatest contrasts of the colder season thus were almost as potent as the greater surface warmth of the warmer. The E.-W. trough thunderstorms were most frequent in late spring and early summer, since the formation of such troughs in the general region of which Ohio is a part occurs between the more or less permanent high pressure areas over the cold Great Lakes and Northeast at this season, and the western portion of the Atlantic subtropical High. The warm-front storms were distinguishable only in winter when well-developed cyclones occurred. Squall-line, or cold-front, storms usually followed in a few hours. Some of the summer thunderstorms classed as "local" probably correspond to this winter type.

DISTRIBUTION OF THUNDERSTORMS IN OHIO

Table I and Figure 1 show the number of thunderstorm days by months and the year in different sections of Ohio. Sections 1, 2, and 4 are plains of about 500-1,000 feet elevation, except for 10 or 15 miles overlap onto the plateau; while 3 and 5 mark the maturely dissected Allegheny Plateau ranging from 500 to 1,540 feet above sea level.

The preponderance of thunderstorms in south over north and west over east was not great in summer, for temperatures and moisture conditions over most of the State are very much alike at that season. In winter, however, the incidence of thunderstorms is appreciably greater in the southwestern half of the State than in the northeastern half. This seems to result from the warm, moist winds in winter coming from the southwest, and the cold, dry ones generally from the northwest. Thus there should be in the southwest the highest temperature and largest moisture content, and also the largest contrast between the warm wind and the oncoming cold one, conditions most favorable to thunderstorms.

The thunderstorms of 1917 follow closely the usual expectation of high incidence from May to August, with the peak in June. The earlier months of the year, part of the mild winter of 1916-17, had many more thunderstorms than the last two months, at the onset of the very cold winter of 1917-18. The year as a whole was unusually thundery. From April 17 to September 7 there were but 22 out of the 144 days without reported thunderstorms.

DIURNAL INCIDENCE OF THUNDERSTORMS[6]

Table II shows that in winter there were more thunderstorms by night than by day and more in the early than in the late half of the night. Winter thunderstorms are the result of the development of excessive lapse rates owing to over and under running winds. At night when there is no solar heating in progress there is a minimum of friction with the ground, and therefore a maximum of opportunity for the unobstructed flow of warm, moist air at a moderate elevation. The cloud sheet at the top of such a flow of warm air may be in part responsible for thunderstorms at night, for it protects the warm layer of air against much loss of heat by radiation upward. The slight excess of the first over the last half of the night may be attributable to the observers sleeping more in the latter half.

In spring and autumn, the dominance of cyclonic conditions in producing thunderstorms is in evidence in

[4] Cf. W. M. Davis, Elementary Meteorology, 1894; W. J. Humphreys, Physics of the Air, 1920; and C. F. Brooks, The local, or heat, thunderstorm, Mo. WEATHER REV., June, 1922, 50:281-284.

[5] Loc. cit., pp. 331-350, maps.

[6] Cf. J. v. Hann, Neue Beiträge zur Kenntnis der Täglichen Periode der Gewitter, *Met. Zeitschr.*, Feb., 1915, 32:73-82, 4 figs.

the rather even distribution throughout the quarters of the day, though the importance of daytime heating appears in the afternoon and evening maximum and the morning minimum.

Early summer brings a great increase in thunderstorms, and a great prepönderance of afternoon and evening thunderstorms, these occurring on practically three-fourths of all days with thunderstorms. The formation of thunderstorms by cyclonic action becomes relatively less important. The period from midnight to 6 a. m. has the least of any quarter of the day. Of the different types, the sunny, local thunderstorms naturally show the greatest response to daytime heating, and the cloudy, E.-W. trough ones the least.

Cyclonic and trough thunderstorms in summer are in many instances really indistinguishable from local thunderstorms. They are classified according to the presence or lack of a definite low-pressure area evidently dominating the situation. As more thunderstorms occur in clear, quiet weather when general conditions are favorable than in partly cloudy, windy weather, the percentages shown in the table are made up mostly of storms occurring in weak cyclones, and so those scarcely distinguishable from local thunderstorms.

It is not surprising, therefore, that storms occur after noon on about four-fifths of the days with storms of the cyclonic type.

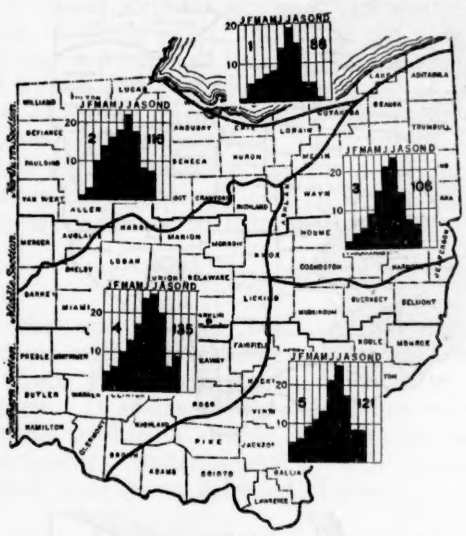


FIG. 1.—Monthly and annual incidence of thunderstorms in 1917, by geographic divisions

In May and June, 1917, there was a considerable prevalence of E.-W. troughs, with long periods of cool, cloudy weather. Under these circumstances, the E.-W. trough thunderstorms showed the same lack of diurnal variation found in cooler months, though, as with the cyclonic and local types the first quarter of the day was the least stormy.

From July to September, 1917, ordinary summer weather prevailed. Local thunderstorms were distributed about as in early summer, except that more began before noon. On 30 per cent of the days with heat thunderstorms such early starts occurred, as compared with but 10 per cent in May and June. With E.-W. troughs less pronounced than in May and June, the diurnal heating had a greater effect on the incidence of thunderstorms. They occurred in the afternoon on three-fourths of the days having the E.-W. trough type. In general, four-fifths of the storms occurring any time in the afternoon were in existence during each of the periods 2–4 p. m. and 4–6 p. m.

THUNDERSTORM MOVEMENTS—PROGRESS AND GROWTH

Thunderstorms, as is well known, move with a direction and speed which are the average for the winds affecting the main body of the cloud. But these may not be the same for all stages of growth. A storm in its youth may occupy a smaller vertical extent than in its maturity; therefore, if it formed in a moderately shallow easterly wind, then grew up into a westerly one above, the thunderstorm might move first from the east and then from the west. Even if the progressive movement does not change, the more or less irregular expansive growth characteristic of thunderstorms often makes them appear to take erratic strides. The front usually advances faster than the middle, and, when the movement is slow, the rear may grow so rapidly as to make the storm "return" to a place already passed.

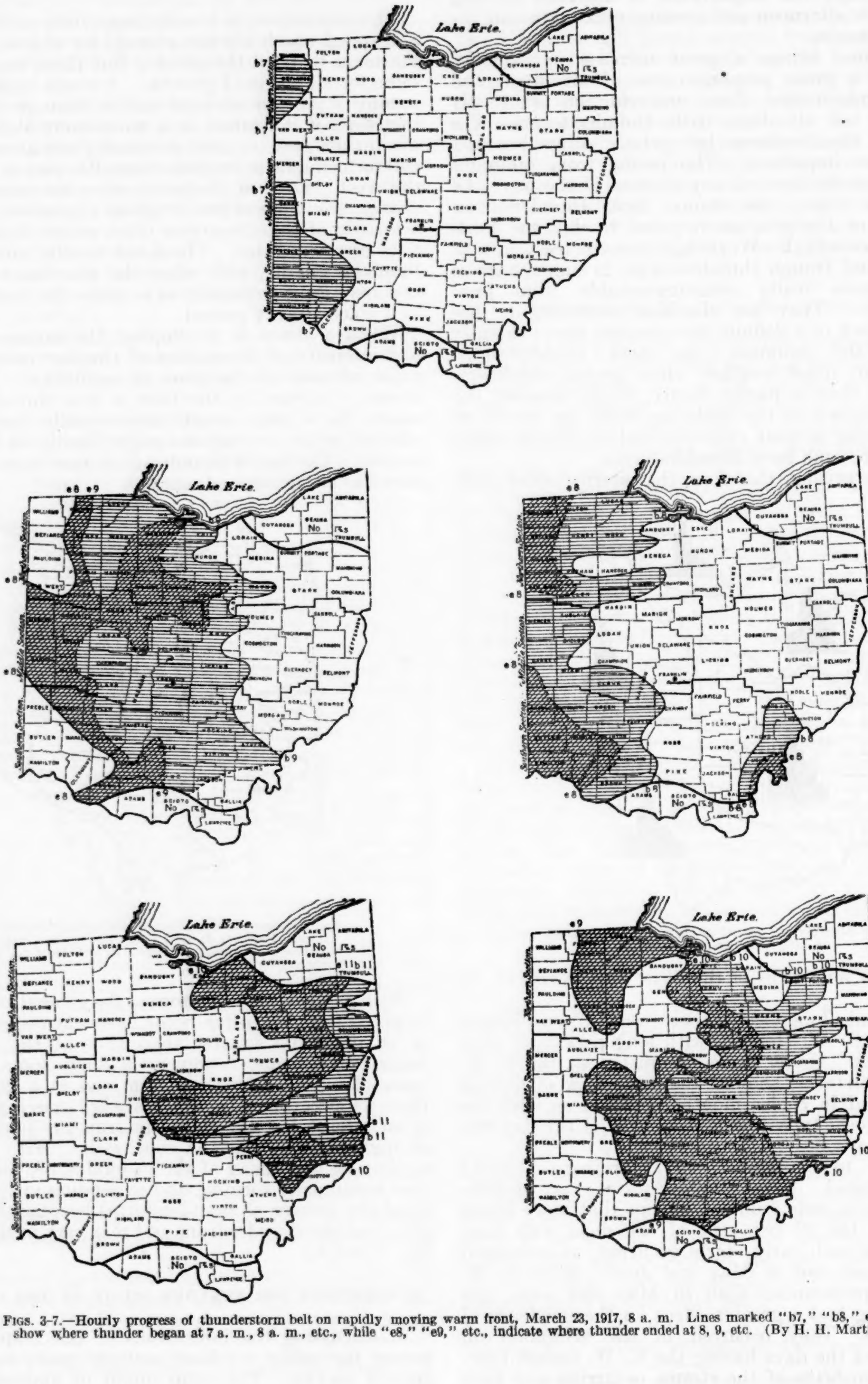
When a storm is developing, the increasing number and intensity of its crashes of thunder result in a very rapid advance of the zones of audibility. Thus, a new storm, if plotted by the time of first thunder, may advance, for a time, much more rapidly than its actual motion; while a dying one might hardly be heard before arrival. The use of thunderstorm rain-fronts in plotting thus has an obvious advantage.

FIG. 2.—Isobronts—first thunder in a warm-front group of storms, February 23, 1917, a. m. The marked irregularities are owing mostly to the local formations of storm in a general belt

With cyclonic thunderstorms, the general zone or zones in which thunderstorms occur moves at a speed the same as or somewhat greater than that of the low center. Individual storms, however, in such zones commonly move slantwise across the zone and at a greater speed than its progress. In the eastward moving squall-line of an intense low the thunderstorms are likely to travel at high speeds from the southwest. With old storms tending to run ahead of the general zone, and with new ones continually forming and expanding in several directions the system of thunderstorms becomes highly complex, and the thunder front and rear very irregular. (See figs. 2 and 3.)

SUGGESTIONS FOR FURTHER STUDY OF THE OHIO MAPS

In discussing the indications of the maps and preparing the tables we have scarcely made more than a general survey. The maps might be approached again with such questions as: The relations between individual and group thunderstorm movements and those of lows;



FIGS. 3-7.—Hourly progress of thunderstorm belt on rapidly moving warm front, March 23, 1917, 8 a. m. Lines marked "b7," "b8," etc., show where thunder began at 7 a. m., 8 a. m., etc., while "e8," "e9," etc., indicate where thunder ended at 8, 9, etc. (By H. H. Martin.)

the growth and decay of particular storms; the local incidence of thunderstorms, including their splittings and mergings and tendencies to follow topographic features, and the bi-hourly distribution by types, by sections, and by seasons. Unfortunately, the data are not adequate for the pursuing of such studies far, for the reports of neighboring observers are often difficult, if not impossible, to coordinate, and locations sometimes uncertain owing to stations being too far apart; generalizations of several small storms into one report; inaccuracies of 5, 10, or 15 minutes in time reporting; even uncertainties of an hour in the time used, and sometimes a question as to the date given.

With the use of data not mapped other research could be attempted. The automatic records at the several regular Weather Bureau stations in Ohio and near by, including the aerological observations at Royal Center, Ind., might be studied in detail for important thunderstorm days, and the sequence of events at the several stations coordinated. In this way, the causes of the thunderstorms, the distribution of which have been mapped, could be more definitely established than from the mere comparison of the thunderstorm maps with the 7 a. m. weather maps. In such an investigation the 7 p. m. manuscript weather maps would also be helpful.

A study might well be made of the influence of the distribution of wet ground, maximum temperatures, and winds, on the incidence of local thunderstorms. This is suggested by the observation, made in Texas, of thunderstorms on alternate days. Similar alternations appear several times in Ohio July 7–25, 1917. After a thundershower, the air is relatively dry for a day or two, and the ground is kept relatively cool by evaporation. These conditions are adverse to thunderstorm formation.

CONCLUSION

Those who are familiar with the results of earlier investigations will have recognized in the information obtained from this Ohio study much that is merely confirmatory. It seems evident that new researches on thunderstorm problems should now be intensive, with the investigators instrumentally well equipped and making their studies on selected storms.

TABLE I.—*Geographic and seasonal incidence of thunderstorms in Ohio, 1917*

[Compiled by G. H. B.]

	1. Local	2. Cyclonic	3. N.-S. trough	4. E.-W. trough	5. Steer. line	Total
Section 1, Lake Shore. (See Fig. 1):						
January	0	1	0	0	0	1
February	0	2	0	0	3	5
March	0	2	3	2	0	6
April	0	1	3	3	0	7
May	0	1	1	6	1	8
June	2	7	1	5	0	14
July	8	3	4	5	0	19
August	1	2	6	6	0	15
September	0	2	0	3	0	5
October	0	1	3	0	1	5
November	0	1	0	0	0	1
December	0	0	0	0	1	0
Year	11	23	21	30	5	86
Section 2, Northwest. (See Fig. 1):						
January	0	1	0	0	0	1
February	0	1	1	0	3	3
March	0	2	5	3	2	10
April	0	2	5	7	1	14
May	0	4	1	9	2	16
June	3	8	1	8	1	18
July	10	5	4	5	0	22

TABLE I.—*Geographic and seasonal incidence of thunderstorms in Ohio, 1917*—Continued

	1. Local	2. Cyclonic	3. N.-S. trough	4. E.-W. trough	5. Steer. line	Total
Section 2, Northwest—Con.						
August	1	2	7	7	0	17
September	0	3	2	5	0	8
October	0	3	3	0	1	7
November	0	0	0	0	0	0
December	0	0	0	0	0	0
Year	14	31	29	44	10	116
Section 3, Northeast. (See Fig. 1):						
January	0	2	0	0	0	2
February	0	2	2	0	2	4
March	0	0	3	3	0	5
April	0	2	4	3	1	9
May	0	4	1	10	2	15
June	4	11	2	8	1	21
July	9	4	5	5	0	23
August	1	2	4	7	0	14
September	1	3	0	3	0	7
October	0	3	2	0	1	6
November	0	0	0	0	0	0
December	0	0	0	0	0	0
Year	15	33	23	39	7	106
Section 4, Southwest. (See Fig. 1):						
January	0	2	0	0	4	5
February	0	3	3	0	2	6
March	0	1	6	3	2	10
April	0	4	4	5	1	13
May	0	4	1	10	4	17
June	4	13	2	10	1	24
July	12	5	4	5	0	25
August	4	2	6	8	0	20
September	1	1	1	5	0	6
October	0	4	3	7	1	9
November	0	0	0	0	0	0
December	0	0	0	0	0	0
Year	21	39	30	53	15	135
Section 5.—Southeast (see fig. 2.):						
January	0	1	0	0	4	5
February	0	1	4	0	2	6
March	0	0	6	2	2	9
April	0	3	4	5	2	11
May	0	4	1	8	4	13
June	2	11	2	9	1	21
July	9	7	5	5	0	25
August	3	1	6	7	0	17
September	0	1	0	6	0	6
October	0	4	8	1	1	8
November	0	0	0	0	0	0
December	0	0	0	0	0	0
Year	14	33	36	43	16	121
Ohio as a whole:						
January	0	2	0	0	4	5
February	0	4	4	0	4	9
March	0	2	6	3	2	10
April	0	5	5	7	1	17
May	0	6	1	15	4	21
June	5	12	2	11	1	27
July	12	7	5	6	0	26
August	5	2	8	9	0	24
September	1	4	3	6	0	12
October	0	8	3	1	1	13
November	0	1	0	0	0	1
December	0	0	0	0	0	0
Year	23	54	37	58	17	165
Section 1	11	23	21	30	5	86
Section 2	14	31	29	44	10	116
Section 3	15	33	23	39	7	106
Section 4	21	39	30	53	15	135
Section 5	14	33	36	43	16	121
State	23	53	37	58	17	165

	Section 1	Section 2	Section 3	Section 4	Section 5	State
January	1	1	2	5	5	5
February	5	3	4	6	6	9
March	6	10	5	10	9	10
April	7	14	9	13	11	17
May	8	16	15	17	13	21
June	14	18	21	24	21	27
July	19	22	23	25	25	26
August	15	17	14	20	17	24
September	5	8	7	6	6	12
October	5	7	6	9	8	13
November	1	0	0	0	0	1
December	0	0	0	0	0	0
Year	86	116	106	135	121	165

TABLE II.—*Diurnal incidence of thunderstorms by quarters—Percentages of days with thunderstorms (T.) during which thunderstorms occurred in each quarter of the day*

[Compiled by C. F. B.]

Month and class	Section 1 (Lake)					Section 2 (NW.)					Section 3 (NE.)				
	12–6 a. m.	6 a. m.–12	12–6 p. m.	6 p. m.–12	T.	12–6 a. m.	6 a. m.–12	12–6 p. m.	6 p. m.–12	T.	12–6 a. m.	6 a. m.–12	12–6 p. m.	6 p. m.–12	T.
January and February:	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Days*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Days*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Days*
Cylonic and N.-S. trough	33	0	33	67	3	0	0	67	67	3	17	50	0	67	6
E.-W. trough and Warm-front	67	33	33	0	3	67	67	0	0	3	50	100	50	0	2
All	50	17	33	33	6	50	50	50	50	4	33	83	17	67	6
March, April, October, and November:															
Cylonic and N.-S. trough	36	29	50	57	14	16	32	58	47	19	23	38	77	31	13
E.-W. trough and Warm-front	38	13	50	75	8	43	29	71	50	14	50	38	63	63	8
All	42	26	58	74	19	29	32	68	52	31	35	40	75	45	20
Cooler months	44	24	52	64	25	31	34	66	51	35	35	50	61	50	26
May and June:															
Local	0	50	50	0	2	0	0	100	33	3	0	0	75	75	4
Cyclonic and N.-S. trough	30	20	70	90	10	7	43	93	79	14	28	16	89	72	18
E.-W.trough and Warm-front	36	36	55	73	11	33	48	57	62	21	30	55	60	55	20
All	32	32	64	77	22	24	44	82	74	34	30	39	86	75	36
July, August, and September:															
Local	0	11	89	44	9	0	36	82	82	11	0	27	91	64	11
Cyclonic and N.-S. trough	32	21	68	53	19	25	42	83	65	23	55	45	65	70	20
E.-W. trough and Warm-front	21	7	50	43	14	12	35	88	59	17	19	37	75	44	16
All	23	15	72	51	39	17	42	91	72	47	32	41	79	63	44
Warmer months	26	21	68	61	61	20	43	87	73	81	31	40	82	68	80
Year (1917)	31	22	64	61	86	23	40	81	66	116	32	42	77	64	106

Month and class	Section 4 (SW.)					Section 5 (SE.)					Average per cent all sections of Ohio				
	12–6 a. m.	6 a. m.–12	12–6 p. m.	6 p. m.–12	T.	12–6 a. m.	6 a. m.–12	12–6 p. m.	6 p. m.–12	T.	12–6 a. m.	6 a. m.–12	12–6 p. m.	6 p. m.–12	T.
January and February:	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Days*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Days*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Days*
Cyclonic and N.-S. trough	25	25	38	50	8	33	50	33	50	6	22	25	34	60	10
E.-W. trough and Warm-front	67	33	0	33	6	67	33	0	33	6	64	53	17	13	6
All	45	36	27	55	11	55	45	18	45	11	47	46	29	50	14
March, April, October, and November:															
Cyclonic and N.-S. trough	43	38	52	52	21	50	39	39	39	18	34	35	55	45	27
E.-W. trough and Warm-front	46	46	54	69	13	55	36	36	55	11	46	32	55	62	15
All	47	42	56	63	32	41	30	30	36	36	39	34	57	54	41
Cooler months	47	42	49	60	43	45	34	28	38	47	40	37	51	53	55
May and June:															
Local	0	0	50	50	4	0	0	100	50	2	0	10	75	42	76
Cyclonic and N.-S. trough	30	25	80	70	20	33	28	83	78	18	26	26	83	78	21
E.-W. trough and Warm-front	58	46	54	54	24	67	67	57	38	21	45	50	57	56	29
All	50	38	78	73	40	59	56	85	68	34	39	42	79	73	48
July, August, and September:															
Local	0	35	88	53	17	0	42	100	33	12	0	30	90	55	18
Cyclonic and N.-S. trough	47	42	68	74	19	67	83	94	61	18	45	47	76	77	28
E.-W. trough and Warm-front	28	56	89	89	18	22	50	83	56	18	20	37	77	59	21
All	28	48	88	78	50	32	58	88	50	50	26	41	84	63	62
Warmer months	38	43	83	76	90	43	57	87	57	84	32	41	81	67	110
Year (1917)	40	43	72	70	133	43	49	65	50	131	34	39	72	62	165

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FIG. 1.—Hail at Rapid City, S. Dak., July 18, 1924. Photograph made 20 or 30 minutes after hail ceased falling. about 2½ inches on ground at that time. All hail in the open disappeared in about three hours

FIG. 2.—Hail at Rapid City, S. Dak., July 18, 1924

SEVERE HAILSTORM AT RAPID CITY, S. DAK., AND VICINITY JULY 18, 1924

HARLEY N. JOHNSON, Meteorologist

[Weather Bureau, Rapid City, S. Dak., July, 1924]

The most severe hailstorm of record at the local Weather Bureau occurred in Rapid City and vicinity during the early afternoon of July 18, 1924. This hailstorm was the most severe and lasted the longest of any the writer has ever experienced. Hail began at 1:19 p. m. accompanied by rain, driven by a high wind that reached an extreme velocity of 52 miles an hour at 1:28 p.m., the storm approaching from the northwest. At 1:32 p. m. the wind shifted to the east for a few minutes, then to the northeast at 1:45 p. m., diminishing in velocity with the shifting of the wind.

The hail barrage lasted 36 minutes and was accompanied by excessive precipitation that continued throughout the duration of the storm, which ended at 1:55 p. m., 1.49 inches of precipitation occurring. One period of five minutes gave 0.40 inch. After the storm the raingage receiver was found to be half full of hail and when melted measured 0.27 inch. It is estimated that 4 inches of hail fell during the storm. Three inches remained on the roof of the Federal building after the storm was over. During the progress of the storm the roaring noise made by the storm was deafening. The hailstones ranged in size from that of peas to that of small hen eggs. One stone picked up by the writer measured 1½ inches in diameter. Some reports are to the effect that much larger hailstones were found. Practically all the larger hailstones examined had a soft center. Six inches of a drift of hail in the observer's yard remained at noon of the day following the storm.

From all obtainable reports the hailstorm covered a comparatively small area. The path from west to east, in which direction the storm moved, was about three miles wide and from 20 to 30 miles long. No hail fell more than 2 miles west of Rapid City, and from 20 to 25 miles east, the storm following the Rapid Creek Valley.

The damage done in Rapid City is estimated to be from $100,000 to $150,000, aside from the total loss of all the growing crops, fruit, gardens, etc., within the area of the storm. Trees were stripped of their leaves and branches one-half inch in diameter were broken off by the hail. Large numbers of residences suffered broken windows and damaged roofs. Shingles were shattered and composition roofs pounded full of holes. In the downtown district the north windows suffered damage during the first part of the storm, but when the wind veered to the northwest the windows on the east side of the buildings were almost all broken.

The hail smashed virtually all the cluster light globes on the city's street lighting system, the cost of replacement being estimated to be from $4,000 to $5,000. Damage to the public school buildings is estimated $5,000. The Reimer and Glendenning greenhouses are practically a total loss. The five larger churches in the city suffered broken windows and water-soaked furniture. At the School of Mines 150 window panes were broken and the State cement plant suffered about the same loss.

When the storm ended, people all over town pulled out their snow shovels, long since put away, to shovel the ice blanket off the sidewalks. The sun came out bright and hot, and a heavy white mist hung over the ground as the warm air came in contact with the ice pack.

A NOTABLE HAILSTORM ON JULY 5, 1891

[From notes in the daily journal of July 5, 1891, by Wm. Norrington, Observer, Signal Corps]

Thunder at 3:55 p. m. [strato-cumulus] clouds moving from the northwest and southwest. Wind backed from south to north at 5 p. m. Light rain began at 5 p. m., with high winds from the northwest. (Form No. 1015 shows extreme velocity of 64 miles an hour.) Heavy hail from 5:10 p. m. to 5:15 p. m. Hailstones large as medium-sized marbles to irregular masses as large as hen eggs. Ground white. Windows and gas lamps broken. Storm moved to southeast. Rain and hail after 5:30 p. m. Irregular masses of ice one-half inch in diameter. Rain ended 5:45 p.m. Precipitation, 1.33 inches. Temperature fell from the maximum, 87°, to 57° from 4:40 p. m. to 5:40 p. m. Telegraph line grounded. Hailstorm apparently formed northwest from town about 2 miles and moved in a southwest direction, thence down Rapid Creek easterly about 12 miles, then diverged to the right up Spring Creek.

Damages.—At the gas plant every [window pane] was smashed, a number in the Elkhorn railroad depot, many in the center of the city, including thick plate glass. At the School of Mines 150 lights of glass were broken on all sides of the building. All growing grain down Rapid Creek 12 miles and 8 or 10 miles up Spring Creek was destroyed. The prospects in these valleys were very bright for an extraordinary yield of grain previous to the storm; now hardly a vestige of growing grain is left. Hardly a pane of glass is unbroken in the northeast part of town. Several horses were blinded by hail and were shot to relieve their suffering. Sixteen horses killed. Some of the hail 6 inches in diameter.

THE COEFFICIENT OF PERSISTENCE

By THOMAS ARTHUR BLAIR, Meteorologist

[Weather Bureau, Lincoln, Nebr., August 8, 1924]

In connection with Besson's note on the probability of rain,[6] following one or more days of rain, at Paris, similar tables and calculations may be of interest for an interior station of the United States, as showing the difference in the rainfall régimes in different climatic regions, and as affording a test of the value of his coefficient of persistence.

Three tables prepared in the same way as those of Besson are here presented for Lincoln, Nebr., for the 30-year period, 1894–1923. All traces of precipitation are included in the reckoning, as appears to be the case in Besson's tables. A fourth table is added in which only days with 0.01 inch or more of precipitation are counted. The total number of days of observation is 10,956, and the total number of rainy days, including traces, is 4,312, making the general probability, 0.394.

TABLE 1.—*Number of groups, S, of k consecutive days of rain*

k	1	2	3	4	5	6	7	8
S (observed)	863	588	234	138	76	31	23	10
S (calculated)	1,586	627	247	97	38	15	6	2
k	0	10	11	12	13	14	15	16
S (observed)	8	4	4	2	0	0	0	2
S (calculated)	0.8	0.3	0.1	0.04	0.02	0.01	0.004	0.002

TABLE 2.—*Probability, p_k, of rain when it is known to have rained the k preceding days*

k	1	2	3	4	5	6	7	8	9	10	11
p_k	0.54	0.52	0.56	0.56	0.58	0.62	0.61	0.61	0.64	0.62	0.60

TABLE 3.—*Monthly and annual values of the coefficient of persistence, R*

	J	F	M	A	M	J	J	A	S	O	N	D	Year
p	0.37	0.38	0.37	0.48	0.49	0.50	0.42	0.42	0.38	0.33	0.29	0.30	0.394
p_1	.52	.56	.52	.60	.60	.59	.50	.46	.53	.54	.52	.31	.540
R	.24	.29	.24	.23	.22	.18	.14	.07	.24	.31	.32	.30	.241

[6] MONTHLY WEATHER REVIEW, June 1924, **50**: 308.

TABLE 4.—*Monthly and annual values of the coefficient of persistence, R, traces omitted*

	J	F	M	A	M	J	J	A	S	O	N	D	Year
p	0.17	0.19	0.22	0.31	0.37	0.37	0.27	0.29	0.28	0.21	0.16	0.18	0.252
p_1	.33	.43	.34	.47	.51	.44	.35	.36	.48	.45	.41	.39	.421
R	.19	.30	.15	.23	.22	.11	.11	.10	.28	.30	.30	.26	.226

There are no such long rainy periods at Lincoln as at Paris, but Table 1 shows the same general characteristics, with the first three groups decreasingly less numerous than indicated by the law of probability, and the others increasingly more numerous. The effective probabilities of rain following one or more days of rain, as shown in Table 2, are not so great as those at Paris, but show a similar trend and a similar relation to the general probability. At Paris p_1 is 134 per cent of p, and at Lincoln it is 137 per cent.

The cœfficients of persistence, as set out in Table 3, show the contrast in the character of the rain at the two cities. The annual cœfficient, 0.24, at Lincoln is only 63 per cent of that at Paris, and perhaps gives a fair indication of the general difference between the two places in the persistence of rain, but there is a further difference shown in the monthly values. In the months of June, July, and August, when practically all the rain falls in thundershowers, the probability of rain after one day of rain is very little greater than the general probability, especially in August, but in the fall and early winter months there is a definite and marked increase in the cœfficient, while from January to May[7] the rains are more persistent than the midsummer rains but less so than the autumn rains. By omitting traces, as in Table 4, the probabilities are reduced but the cœfficients are not much altered. In each case the difference in type between the summer and autumn precipitation is distinctly shown.

This simple mathematical expression, the cœfficient of persistence, thus appears to offer a valuable and definite means of characterizing one aspect of rainfall, but it is evident that the use of a single annual cœfficient is less valuable at Lincoln that at Paris. It is, in fact, entirely inadequate at Lincoln, and monthly or seasonal cœfficients must be used.

[7] Mostly cyclonic rains occur in these months.—*Ed.*

METEOROLOGY AT THE TORONTO MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, AUGUST, 1924

The following authors' abstracts are reprinted from the Journal of Scientific Transactions of the B. A. A. S., July 7, 1924. It is the policy of the Association to print in the Journal only the abstracts of scientific papers. The complete papers should be sought in the appropriate scientific periodicals:

SIR NAPIER SHAW, F. R. S.

If the Earth Went Dry

The phenomena of the general circulation of the atmosphere depend fundamentally upon warming at the surface by the sun's rays and on cooling these [?] by outward radiation; but the dominant factor of weather is the modification due to water vapor in the air. In this paper, in order to clear ideas, the reader is invited to regard these two aspects of thermal influence as distinct, and to consider the effect of dry heat alone. We thus form an idea of what the general circulation would be if there were no water vapor at all in the air.

The subject is hypothetical, inasmuch as the actual circulation is generally affected by the condensation or evaporation of water, but its discussion is not necessarily sterile. It is an exercise in some important points of thermal economy; in deserts the conditions postulated are approximately realized, and yet winds, dust storms, and "dust-devils" are not infrequent there; and in the large part of the atmosphere where the temperature is below 270 *t* the relative amount of water vapor, though not by any means without function, is too small to play the dominant rôle.

It is assumed that "dry" air (except for dust) would be perfectly transparent. Radiation received by a perfect absorber normal to the sun's rays would be 135 kilowatts per square dekameter (subject to small variations of the solar constant), and the loss of heat from a surface radiating perfectly (subject to local variation on account of dust) would be $.572 \times (t/100)^4$ kw., and range from 9 kilowatts per (10 meter)^2 for 200 *t* to 46 for 300 *t*. A table is given of the temperatures (between 200 *t* and 402 *t*) at which the loss from a radiating surface would balance the income for given solar altitudes.

The technical discussion is in five sections:

1. A survey of the thermal processes operative in the absence of water vapor: (*a*) The katabatic effect of inclined surfaces cooling in the polar night; (*b*) the slow thermal convection, upward, by the building up of layers of dry air in convective equilibrium over flat solarized surfaces (incidentally the question of superheated air

is dealt with); and (c) the mixing of superposed layers by eddy-motion.

2. An estimate of the flow of air necessary to keep a steady state of temperature on a polar slope under assumed conditions during prolonged nocturnal radiation. A possible value of 300 km. per hour offers a justification for the use of the term "dust blizzard" as descriptive of the weather.

3. An estimate of 2 km. as the probable daily height of a layer in convective equilibrium under a tropical sun.

4. Diagrammatic sections of surfaces of equal temperature and of equal potencial temperature for sunrise and sunset at solstice and equinox. A permanent stratosphere, nibbled daily by a convective troposphere, is presupposed for the purpose of estimating its probable temperature, which is near 300 *t*. The incidental curiosities of temperature are set out.

5. The pressure and winds consequent upon the temperature are sketched, with the conclusion that a polar front would still be operative and a general circulation not dissimilar in some of its main factors from the present form.

SIR FREDERIC STUPART.—*The Variableness of Canadian Winters*

In normal seasons North Pacific cyclonic areas usually move south-eastward, with their centres well off the coast until at about the latitude of Northern British Columbia they enter the continent, while anticyclonic conditions of moderate intensity with low temperature prevail in Yukon and the Mackenzie River.

In certain years, however, the Pacific cyclonic areas are less intense and enter the continent further south, while great anticyclonic developments occur in the far north and sweep southeastward over Canada, accompanied by severe cold waves, which not infrequently reach the Atlantic coast. These conditions lead to abnormally cold winters in Canada.

In other years the North Pacific cyclonic areas appear to be of such intensity that they force their way into the continent in high latitudes and actually prevent the formation of anticyclones and their concomitant low temperature. These conditions lead to mild winters in Canada.

The Meteorological Service is investigating as to whether there is any connection between the temperature and position of the Japan current and the behavior of these cyclonic areas.

F. J. W. WHIPPLE.—*The Diurnal Variation of Pressure: Facts and Theories*

The regular oscillation of pressure shows remarkable regularities all over the globe, and it is, therefore, probable that it is connected in a simple way with its cause. The object of this paper is to emphasise the fact that there is an opening here for speculation as well as for more analysis of the records. The preparation of critical tables of pressure at places where barographs have been maintained for long periods requires international co-operation. Observational material is exceptionally rich in the British Isles, where a number of photographic barographs properly compensated for temperature changes and with open time-scales have been in operation for more than fifty years. The British records indicate that the average diurnal variation of pressure for a given time of year can be regarded as due to the combination of a local wave (a pure sine-curve) and a planetary wave. The planetary wave is not a pure sine curve; the changes in its form conform closely to changes in the sun's declination. It is pointed out that these facts are difficult to reconcile with Lord Kelvin's resonance hypothesis, and in conclusion other objections to that hypothesis are also mentioned.

PROF. W. J. HUMPHREYS.—*The Relation of Wind to Height*

On the average, perhaps, and especially on the equatorial side of cyclones, the wind varies as follows with height: Increases rapidly, but decreasingly so, with height up to 400 to 500 metres above the surface; then decreases slightly through, say, 300 metres; after this increases a little, and then remains, roughly, constant up to round 2,000 to 3,000 metres above the surface; here again often slightly decreases; and then through the next several kilometres increases in proportion to decrease of density. Directions of the wind and its temperature also are interestingly related to height above the surface.

All these observed facts are plausibly explained as effects of mechanical and thermal turbulence.

J. BJERKNES.—*The Importance of Atmospheric Discontinuities for Practical and Theoretical Weather Forecasting*

Empiric investigations show that new-formed depressions usually consist of two oppositely directed air currents, the one warm and the other cold. Initially each current occupies about one-half of the region covered by the depression. The area of the cold air is, however, always increasing, and finally it embraces the whole of the depression in the lower layers. The warm air covers at the ground a correspondingly decreasing space (the warm sector). During the development of the depression, air from the warm sector will escape upwards and spread in higher layers. This motion involves a transformation from potential into kinetic energy (strengthening of the wind and deepening of the depression). The kinetic energy of the depression decreases again as soon as there is merely cold air supply available for the ascending motion. The temperature distribution in the depression thus gives useful indications concerning the expected development.

The result may be formulated mathematically as an equation giving the acceleration of the different air masses relatively to each other. One may thus, at least theoretically, arrive at a mathematical forecast, provided that sufficient observational data are at hand. This is exemplified in a depression passing Central Europe on February 1, 1923.

L. F. RICHARDSON.—*Turbulence and Temperature-gradient among Trees*

The writer has previously derived from theory a criterion for the increase of turbulence, applicable at a height in the free air great compared with the irregularities of the ground. By contrast the present investigation relates to observations made among trees. The temperature gradient was measured by a pair of thermo-junctions placed at different heights. This is compared with the gustiness as shown by a Dines pressure-tube anemometer.

DR. J. S. OWEN.—*The Automatic Measurement of Atmospheric Pollution*

Refers especially to results of the automatic recorder designed by the author for the Advisory Committee on Atmospheric Pollution. The function of this is to measure the pollution of city air by smoke. A short description and references to fuller descriptions are given. The results obtained in London by this apparatus are compared with those of the author's dust counter (*Proc. Roy. Soc. A.*, Vol. 101, 1922) and show a good correspondence. Curves obtained by both methods in investigating the effect of suspended matter on obstruction of light are given; the relation between obstruction and dust content is shown to be nearly a straight-line one. From this comparison it appears that 1 milligramme of dust per cubic metre has the same effect as about 10,000 particles per cubic centimetre; thus 10^{10} smoke particles weigh 1 mg. approximately. The size of suspended dust particles is fairly uniform, but tends to increase during smoke fogs, probably due to their rapid formation giving insufficient time for grading by settlement.

J. PATTERSON.—*Upper-Air Observations in Canada*

Upper air observations were commenced in Canada in 1911, but were partially interrupted by the war. It has not yet been possible to get balloons for carrying instruments equal to those of pre-war days; there are, however, good prospects of overcoming this handicap in the near future. During the past year an automatic apparatus for calibrating the meteorographs has been installed and the Dines meteorograph simplified. The results of the sounding balloon ascents during the past five years and the observations with pilot balloons in the Arctic will be discussed, together with the prospects of permanently extending the field of observations in the upper air to this region.

PROF. H. H. KIMBALL.—*The Determination of Daylight Intensity from Automatic Records of Total Solar and Sky Radiation*

Colour temperatures of sunlight and skylight, and the spectrum energy curves of radiation from the sun and from the sky have been utilised to determine approximately the spectrum energy curve of the total radiation received on a horizontal surface, and its variation with atmospheric transmissibility and the solar zenith distance.

A comparison of these latter curves with the curve of "visibility of radiation" permits a prediction to be made of the variations to be expected in the ratio between the intensities of the vertical components of daylight and of the total solar and sky radiation.

This ratio has also been determined experimentally by comparing photo metric measurements of daylight illumination on a horizontal surface with continuous records of the total solar and sky radiation made by a U. S. Weather Bureau thermoelectric pyrheliometer horizontally exposed.

The above investigations have been confined to skies that were either cloudless or else completely covered with clouds.

PROF. W. J. HUMPHREYS.—*Rainmaking*

Several of the more persistently urged schemes for producing rain are considered in respect to the underlying principles involved, and measured quantitatively to determine the question of their practical use.

These schemes include, especially, the production of loud noises; the use of chemicals; mechanical or forced convection; fog-collecting screens; dusting the sky; spraying liquid air on to clouds; and sprinkling clouds with electrified sand.

None of these rainmaking methods is practicable in the commercial sense of the term; but each, when treated quantitatively, is full of meteorological interest.

THE SECTION ON METEOROLOGY OF THE INTERNATIONAL GEODETIC AND GEOPHYSICAL UNION

By B. M. VARNEY

[Weather Bureau, Washington, August 19, 1924]

In view of the meeting of the International Geodetic and Geophysical Union at Madrid, October 1-8, 1924, readers of the REVIEW may be interested in a summary of the scientific activities of the Section on Meteorology since the meeting of the Union in Rome in May, 1922. This summary is based on the report of the Executive Committee of the Section for 1922-1924, the committee being composed of the following persons: President, Sir Napier Shaw; vice presidents, Dr. C. F. Marvin and Col. E. Delcambre; secretary, Prof. Filippo Eredia; and members G. C. Simpson, A. Wallén and P. Gamba. The program of the Madrid meeting includes the consideration not only of the matters dealt with in the report here summarized, but of a large number of other proposals, from the various National Committees of the Union, which were not included in the report. In order to indicate the scope of the discussion at the meeting, these latter items will be given after the summary.

The following scientific matters receive attention in the report of the executive committee:

1. Cloud investigations.
2. Applications of modern statistical method to meteorological data.
3. Composition of the air in the upper atmosphere.
4. Exploration of the upper air.
5. Atmospheric dust.
6. Solar radiation.
7. Methods of weather forecasting in various countries.
8. Convection.
9. Relation of sunspots to terrestrial magnetism and the weather.
10. Relation between the Section on Meteorology of the International Geodetic and Geophysical Union and the International Meteorological Committee.
11. International publication of upper air data.
12. Exchange of publications.

Cloud investigations.—At the Rome meeting in 1922 the Section adopted a resolution to the effect that members of the Union interested in problems concerning cloud types be asked to submit suggestions as to matters for investigation to the Commission newly appointed by the International Meteorological Committee for the purpose of carrying out cloud studies from the points of view of pure and applied meteorology. This Commission was continued at the Utrecht meeting of the International Meteorological Committee, Colonel Delcambre being elected its president to fill the vacancy left by the retirement of Sir Napier Shaw.

Application of modern statistical method to meteorological data.—This matter the Section referred to the International Meteorological Committee for action. Though that committee has not met for the purpose of considering scientific matters since May, 1922, the International Commission on Agricultural Meteorology secured the adoption at the Utrecht conference of the following resolution: "The Commission recommends for studies in agricultural meteorology the use of frequency values and values for the duration of specified temperatures, humidity, etc., as determined by the individual countries."

A proposal by the Italian National Committee for a joint meeting of the Section on Meteorology with the Section on Hydrology for the purpose of discussing modern statistical methods, was made an order of the day for the Madrid meeting. The Italian Committee will send to the national committees a memorandum summarizing the various methods with their practical applications.

Composition of the air in the upper atmosphere.—A redetermination of the hydrogen content of the atmosphere appearing to be desirable, the president has taken steps to determine the procedure necessary. Doctor Onnes, of the University of Leyden, and Professor Lindemann, of Clarendon Laboratory, Oxford, have hopes of making very exact determinations of the hydrogen content of air samples from widely different localities and from various altitudes, by means of low-temperature methods. If the content be found to vary, either as between localities or at different hours in the same locality, atmospheric hydrogen would appear to be of local origin, and its universal diffusion through the atmosphere therefore improbable. It is proposed that the section ask the Chemical Union to carry out determinations of this content from time to time by low-temperature methods in places where facilities are available. Cooperation to this end by the chemists of various countries would make possible an answer to the question as to whether hydrogen in definite proportion is a normal constituent of the lower atmospheric strata, before attack is made on the problem of what steps are necessary to obtaining air samples from the upper strata.

Observation on meteors discussed by Lindemann and Dobson (Proc. Roy. Soc., 102, No. A. 717, January, 1923), show that the assumption of the existence in the high atmosphere of a gas lighter than hydrogen is unnecessary. Furthermore, spectroscopic study of the upper atmosphere by specialists in that field (Rayleigh, Fowler, Vegard) give no evidence of the presence of hydrogen in the upper layers up to the height of the atmosphere determined by the visible aurora. Vegard suggests that the typical green line in the spectrum of the aurora even at the greatest heights may be due to nitrogen in a modified physical state and not at all to hydrogen or helium.

Exploration of the upper air.—Proposal has been made that the cooperation of aero clubs and yacht clubs be asked in upper-air exploration by means of sounding balloons. Pursuant to this end the following steps have been taken:

(*a*) The assembly of details as to apparatus useful in sounding and pilot-balloon work at sea and on deserts. Information has been collected on types of balloons and meteorographs adaptable to use by persons interested in carrying out such studies.

(*b*) Instruction in the details of observational procedure adapted to use by persons perhaps not very familiar with meteorological methods was found necessary, and for this purpose reprints of the section in de Bort and Rotch's memoire dealing with the technique of observations at sea, with English translation, have been made.

(*c*) The form of request to ships has received attention, the superintendent of navy services at the British Meteorological Office, Commandant Garbett, collaborating.

(*d*) This official also designed and tested a model float for the purpose of sustaining the balloon and meteorograph after descent. The device was found thoroughly satisfactory.

(*e*) Tests have also been carried out on methods of using the sextant (in place of the theodolite) in following the flight of balloons at sea, this work being based on the paper by Wegener and Kuhlbrodt (Archiv der Deutschen Seewarte, 40, Jahrg. 1922, No. 4) on that subject.

Atmospheric dust.—Acting upon resolution by the Section at the Rome meeting, Owen's dust counters have been distributed by the Section office to the following countries, with the expectation that results would be reported to the office: Australia, Belgium, Brazil, Canada, France, Great Britain, Greece, Italy, Poland, Portugal, Roumania, Spain, Sweden, and the United States, together with one to Professor Gamba of the executive committee. The office suggested that the days chosen for dust observation be those already designated as international days for upper-air work. Doctor Kimball, in charge of the observations at Washington, arranged for the obtaining of dust samples from high altitudes by means of airplanes, the first trial being carried out on April 6, 1923. Doctor Wallén, director of the meteorological-hydrographical organization at Stockholm, proposes to use the same method.

Of observations at the earth's surface, the committee has received from Washington a complete set for every international day beginning with January, 1923, together with details of observations on the 4th and 5th of January, 1923 at Uccle, and observations from Greece. In the latter cases much difficulty in determining the count has arisen from the lack of suitable microscopes. Australia also reports difficulty on this score. It is believed that a high powered microscope, though not a part of the usual meteorological equipment, should be available for the work in each case, and that it could perhaps be loaned from the apparatus of related scientific institutions. It is held desirable that the Section authorize some communication on this point with member countries.

Professor Gamba has sent to the president a sample of a visibility gage of his own design. This instrument is described in his paper "le osservazioni della nebbia ed il *nefelemetro* Gamba," (Bollettino bimensile della Societa meteorologica Italiana, 4-6 November, 1921). An uncompleted instrument designed for the same purpose and consisting of several plates of clouded glass, to be held between the observer and the distant object, is available at London, but to date no comparison of the two has been made.

Solar radiation.—The Section office hopes to be able to distribute at the Madrid meeting a report on the state of our knowledge concerning solar, earth, oceanic and atmospheric radiation, and their bearing on the general circulation of the atmosphere.

Ladislas Gorczyński, Director of the Polish Meteorological Service, recently returned from the Far East, presented at the Utrecht Congress in September, 1923, a brief report on the results of this expedition, undertaken for the study of the intensity and character of solar radiation in equatorial regions. This report is published in Comptes Rendus for October 22, 1923, p. 754. Gorczyński suggests that this reconnaissance study be followed by others in various parts of the globe, for the investigation of partial intensities of the solar radiation, especially on low latitude mountain peaks (British India, South America), in deserts (mountainous parts of the Sahara, Morocco, plains of Egypt) and also on a small oceanic island. The instruments required for such expeditions will probably be exhibited by Gorczyński at Madrid.

The British national committee has submitted the following recommendation at the instance of Mr. F. L. Richardson: "That the section should take steps to obtain observations from aeroplanes upon the luminosity reflected from the earth's surface as compared with that from a cloud, using an *iris-photometer*, of which a scale drawing is submitted."

Methods of forecasting in various countries.—In accordance with a resolution by the Section, a circular letter of inquiry as to the methods of forecasting in use by individual countries was sent in January, 1923, to the directors of the meteorological services of countries belonging to the Union and to countries which had been invited to join the International Research Council. By the middle of July, 1923, 16 replies had been received. It was therefore decided to issue to the different countries a pamphlet containing all the replies.

In this connection, Colonel Delcambre has pointed out that one of the objects of the letter was to seek international exchange of ideas with a view to arriving at complete agreement on the International Code used in the transmission of meteorological reports. He expressed the belief that the short statements asked for and received were inadequate for this purpose, and referred to treatises such as that by J. Bjerknes and H. Solberg as examples of the fullness of treatment desirable. Similar extended statements are in print on the methods in use at the British Meteorological Office (Shaw: Forecasting Weather, 2d ed., October, 1923) and in the United States (Henry, Bowie, Cox, and Frankenfield: Weather Forecasting in the United States, Washington, 1916). Schereschewsky and Wehrle's "Cloud Systems" is a contribution from the French Meteorological Office of interest in this connection.

The Section office decided to send forward the pamphlet above referred to, and to bring before the Section at Madrid the question of ways and means of attaining the ideal set forth by Colonel Delcambre.

Convection.—The committee reports that no move has been made to ask international cooperation in this matter. A statement of the problem and of methods for its solution is presented in a paper in the Quarterly Journal of the Royal Meteorological Society for January, 1924, under the title: "Resilience, cross-currents, and convection." Copies of this paper will be distributed at an appropriat time.

Relation of sunspots to terrestrial magnetism and the weather.—In view of the fact that spots and terrestrial magnetism are related, but that a connection between spots and weather has not yet clearly been made out, the British national committee has, at the suggestion of Dr. Chree, president of the section on terrestrial magnetism and atmospheric electricity, made the proposal: "That the section should arrange for an examination of weather experienced on *quiet* magnetic days as compared with that experienced on *disturbed* days."

Relation between the Section on Meteorology of the International Geodetic and Geophysical Union and the International Meteorological Committee.—The Union having asked that the International Committee consider the question as to whether or not there was duplication of functions between the two bodies, and if so what measures to prevent it could be devised, the Conference of Directors very carefully went over the matter at its meeting in Utrecht in September, 1923, and as a result came to the conclusion, embodied in a resolution, that such duplication did not exist. It is pointed out that the purpose of the International Committee is solely to consider

matters that concern the operation of the respective systems of stations as such and hence are of interest to all governmental meteorological services. The Conference of Directors offered thorough cooperation, and expressed the hope that the Union would as soon as possible enroll representatives from all nations, as the International Committee had done.

By way of indicating clearly the nature of membership in the Committee, a former ruling of the Conference of Directors was reworded thus: "The office of the International Committee shall invite in person to meetings all the directors of governmental meteorological organizations, separate invitations being sent to the directors in each country." Thus regular membership in the Committee is limited strictly to chiefs of government meteorological services having systems of stations under their direction. On the other hand, it is intended that the Union shall also include directors of public and private observatories engaged in meteorological research, but not under the direction of any government bureau; and that, concerning matters of more general scientific interest, plans for international cooperation shall be referred to the Union. Dr. Simpson has asked that this matter also be considered by the International Committee (as distinguished from the Conference of Directors).

International publication of upper air data.—This matter has a bearing on the relations just discussed. The Union's Commission on upper air exploration is giving attention to the publication of upper air data in accordance with its (the Commission's) recommendation at Bergen in 1921 that "the preparation and publication of data should be under the direction of an office and that the expenses of this office should be paid by international contribution." Inquiries sent to institutions in various countries have not resulted in their indicating definitely the amounts they would contribute.

In the opinion of the executive committee, it is not desirable to ask a contribution for a specific meteorological undertaking of a country which makes a yearly contribution to the Union. The question as to whether the Union should help defray the expenses of one year's issue as a model of the kind of publication intended will be brought before the section meeting at Madrid. It may be noted that the Section on Meteorology possesses a principal of 32,542 fr. and an annual income of 22,400 fr. The latter amount should by the time of the meeting come to 44,800 fr. Thus the Union could make a contribution toward the printing of the upper-air data in the name of the member countries without prejudicing future discussion of the matter.

Exchange of publications.—The office of the International Geodetic and Geophysical Union, in a letter on the exchange of publications between the International Research Council and a committee of the League of Nations, has suggested that the publications of the Section on Meteorology be sent to the Secretary of the International Committee on Intellectual Cooperation, Office of the League of Nations, Geneva, in exchange for certain publications of the League of Nations.

This raises a question concerning places where section members could find available any publications received in exchange. Since the answer to this question depends on what provision it is proposed to make for the housing of the property of the Research Council and of its various unions, the following proposal has been made an order of the day for the Madrid meeting: "That the Union should take steps to obtain from the Research Council a statement as to the libraries, in the different countries, in which the publications of the Unions should be assembled, as well as publications received in exchange for those presented to other organizations."

The proposals of the National Committees not included in the report of the Executive Committee, but which form a part of the agenda for the Madrid meeting, are given below:

Belgium.—(*a*) A method of counting dust particles on the Owens cover glasses against a black background without immersion.

(*b*) The technique of aerological soundings.

United States.—(*a*) The preparation of a Northern Hemisphere daily weather map.

(*b*) The organization of a study of the atmospheric circulation of the globe, including the genesis of cyclones and anticyclones.

(*c*) The extension of pilot and sounding balloon observations to the Arctic and to the Tropics.

(*d*) Improvement of the Gregorian calendar.

(*e*) Proposals to promote the investigation of meteorological phenomena.

(*f*) Possible methods of exploring the upper air to heights beyond those already attained by sounding balloons.

(*g*) The problem of atmospheric dust, turbidity, etc.

(*h*) Cloud classification (*a*) for scientific study; (*b*) for use in daily weather reports.

Great Britain.—(Included in report of Executive Committee.)

Greece.—(*a*) Systematic exploration of the [atmosphere over the] Mediterranean Sea.

(Other matter included in report of Executive Committee).

Italy.—(*a*) The measurement of cloud heights.

(*b*) Systematic exploration of the atmosphere over the Mediterranean Sea.

(Other matter included in report of Executive Committee.)

Switzerland.—Communication by Prof. A. deQuervain "On the high-altitude scientific station at 3,500m. on the Jungfrau summit." (Illustrated.)

"This station, which will have the advantage of being accessible during almost the entire year, should primarily serve meteorology and geophysics, but also astronomy and physiology. Built by Switzerland and directed by a Swiss scientific committee, it will in principle be open to scientists of all nations. On this account it appears to be of sufficient international interest for an account of its present status and future prospects to be presented before the Section on Meteorology of the Congress."

NOTES, ABSTRACTS, AND REVIEWS

GUSTAV HELLMANN

(In printing the following translation [8] the MONTHLY WEATHER REVIEW joins with the Meteorologische Zeitschrift in honoring a distinguished scientist.)

The honorary president of the German Meteorological Society, Privy Councillor Professor Dr. Gustav Hellmann, completed on the 3d of July, 1924, his seventieth year.

The Meteorologische Zeitschrift can not let this day pass unnoticed, for he whose anniversary we celebrate has advanced the prestige of our journal not only by his numerous and valuable scientific contributions but also by his efficient work as its editor during the years 1892–1907 and as president of the German Meteorological Society from 1907 to 1923.

Hellmann's first publication in the Journal of the Austrian Meteorological Society dates back to 1875. In it he discussed the important question of what error is incurred in adjusting observations based on a short period by means of a longer record at a neighboring station regarded as normal. The limits within which this procedure is justified were here set forth for the first time. In the same volume we find an essay by Hellmann under the interestingly modern title: "A contribution to the physics of the upper layers of the atmosphere," which pointed out the significance of mountain stations to meteorology.

Previous to the merging of the Austrian journal with the German only one annual volume passed without a communication from Hellmann, and of the 41 volumes of the present Zeitschrift but 5 contain no papers from his pen. It would be superfluous to point out what a fund of meteorological knowledge is contained in these treatises and communications.

Hellmann's editorial activity was made notable by the completion of the bibliography [9] and by the publication jointly with J. M. Pernter of the Hann Memorial Volume. As president of the German Meteorological Society, Hellmann has always regarded as his highest duty the advancement of the interests of the journal.

The Meteorologische Zeitschrift gratefully remembers these labors, and it extends to Herr Hellmann its wishes for a long continuance of bodily health and intellectual activity.

[8] Met. Zeit., 41, July, 1924, p. 197. Translated by B. M. Varney.

[9] The bibliography referred to is probably Hellmann's "Contribution to the bibliography of meteorology and terrestrial magnetism in the 15th, 16th, and 17th centuries." (Part 2 of the report of the Chicago Meteorological Congress, August, 1893, pp. 352–394.)

RADIO DISTRIBUTION OF WEATHER OBSERVATIONS, FORECASTS AND STORM WARNINGS FOR SEAMEN

Under date of August 1, 1924, the Forecast Division of the Weather Bureau has issued a revised circular giving the most recent information respecting the distribution by radio to vessel masters navigating the Gulf of Mexico, the Caribbean Sea, and the adjacent waters of the North Atlantic Ocean of weather observations, wind forecasts, and warnings of hurricanes or other tropical disturbances.

Copies of this circular may be had on application to the "Chief, U. S. Weather Bureau, Washington, D. C.," or to any Weather Bureau office located on the southern coast of the United States.

BIBLIOGRAPHY

C. FITZHUGH TALMAN, Meteorologist in Charge of Library

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Delgado de Carvalho, C. M.
Atlas pluviometrico do nordéste do Brasil. Rio de Janeiro. 1923. unp. 36½ cm. (Min. da viação e obras pub. Inspectoria federal de obras contra as seccas. Pub. no. 53. Serie 1, B. G.)

Dorno, C.
1. Allgemeines aus Meteorologie und Klimatologie. 2. Strahlung. 3. Spezifisch-medizinische Klimatologie und Höhenklima. Braunschweig. 1924. v, 64 p. figs, 22½ cm. (Vorträge gehalten anlässlich des Ferienkurses für Ärzte in Davos am 19.–26. August, 1923.)

Hanzlík, Stanislav.
Podnebía člověk. [Climate and man.] Praze. 1924. 171 p. illus. plates. 21½ cm. (Earth and mankind. v. 53.) [Author, title and text in Bohemian.]

Hesse, Landesamt für Wetter- u. Gewässerkunde.
Wasserstandsbeobachtungen in Hessen im Kalendarjahre 1923 und Zusammenstellung der Beobachtungs-Ergebnisse im Abflussjahre 1923. Darmstadt. [1923.] p. 33–44. 34 cm.

Hurst, H. E.
Rains of the Nile basin and the Nile flood of 1913. Cairo. 1923. 98 p. plates. 26½ cm. (Ministry of public works. Physical dept. paper no. 12.)

Lambrecht, Wilh.
Fabrik wissenschaftlicher Instrumente. Meteorologie, Hygiene, Industrie. Göttingen. n. d. v. p. illus. 25 cm.

McAdie, Alexander George.
Cloud atlas. Chicago. [c1923.] vi, 57 p. illus. tables. diagrs. 21½ cm.

Mathieu (de la Drome).
Le double almanach. Indicateur du temps pour 1924 . . . Paris. [1924.] 128 p. 15 cm.

Norbury, Frank Parsons.
Seasonal curves in mental disorders. 16 p. figs. 20½ cm. (Repr.: Medical journal and record, Apr. 16, 1924.)

Platania, G., & Eredia, F.
Riassunto delle osservazioni meteorologiche eseguite a Catania nel quinquennio 1917–1921. 23 p. 25 cm. (Bollettino dell' Accad. gioenia di scienze naturali in Catania. Fasc. 52, 23 Giug., 1923.)

Rainbolt, Victor.
Town that climate built. The story of the rise of a city in the American tropics. Miami. n. d. 136 p. plates. 20 cm.

Stenz, Eduardo.
Supra variabilitate de constante solare. n. p. n. d. [1 p.] 34 cm. (Extr.: Circulaires l'Observatoire de Cracovie.)
Wtasnósci optyczne atmosfery nad szczytem Tysiny. Krakowie. 1924. 8 p. 24 cm. [Author, title and text in Polish. Summary in English. Optical properties of the atmosphere above the summit of Mt. Lysina Polish Beskids.] (Z. Rocznika observ. astron. Krakowskiego. v. 3, 1924.)

Totten, Ralph J.
General weather conditions at principal Spanish ports. Barcelona. 1924. 9 p. 23 cm. [Manifolded from typewritten copy.]

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY

The following titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

Aero digest. New York. v. 5. August, 1924.
Reichelderfer, F. W. Weather forecasting for airships. p. 84–87.

American meteorological society. Bulletin. Worcester, Mass. v. 5. June–July, 1924.

Alexander, William H. The distribution of thunderstorms in the United States. p. 95–99. [Abstract.]

Alter, J. Cecil. Hitting the ball. p. 109–110. [Relation of climate to baseball.]

Blochman, L. E. A study of long-range forecasting for California, based on an analysis of past rainy seasons. p. 100–101. [Abstract.]

Calvert, E. B. Weather Bureau fruit-spray and harvest-weather service. p. 91–92. [Abstract.]

Clements, F. E. Grassland as a source of rainfall. p. 101. [Abstract.]

Covert, R. N. Lightning fire losses. p. 94. [Abstract.]

Dr. C. LeRoy Meisinger, 1895–1924. p. 82–87. [Obituary. With portrait and list of writings.]

Heat in hats. p. 111. [From St. Nicholas.]

Official airplane altitude records. Notes on Lt. Macready's flight. p. 87–91.

Palmer, Andrew H. Rain gauge readers wanted. p. 107.

Reichelderfer, F. W. Forecasting for rigid airships. p. 94. [Abstract.]

Richter, C. M. Atmosphere and man. p. 102. [Abstract.]

Spencer, J. H. State co-opeation in Maryland. p. 92–94. [Abstract.]

Summers, M. B. Some features of the climate of Alaska. p. 102–103. [Abstract.]

American society of heating and ventilating engineers. New York. v. 30. 1924.

Yagloglou, C. P., & Miller, W. E. Effective temperature applied to industrial ventilation problems. p. 515–539. (July.)

Yagloglou, C. P. Heat given up by the human body and its effect on heating and ventilating problems. p. 597–509. (Aug.) [With bibliography, p. 598.]

Houghten, F. C., & Yagloglou, C. P. Determination of the comfort zone with further verification of effective temperatures within this zone. p. 515–536. (Sept.)

Annalen der Hydrographie und maritimen Meteorologie. Berlin. 52. Jahrgang. 1924.

Maurer, H. Schall- und Funksignale zur Abstandsbestimmung bei Nebel. p. 18–20. (Jan.)

Meissner, Otto. Zur Frage nach der Entstehung der Seebären. p. 14–15. (Jan.)

Plassmann, J. Färbung der tiefstehenden Sonne. p. 15–18. (Jan.)

Schedler, A. Die Zirkulation im Nordatlantischen Ozean und den anliegenden Teilen der Kontinente, dargestellt durch Häufigswerte der Zyklonen. p. 1–14. (Jan.)

Wegener, Alfred. Luftdruck und Mittelwasser am Danmarks-Havn. p. 32–38. (Feb.)

Mey, A. Hangwindmessungen. p. 51–52. (März.)

Castens, Gerhard. Der Wetterdienst der Deutschen Seewarte im Wirtschaftsleben und in der Rechtspflege. p. 125–131. (Juni.)

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING JULY, 1924

By HERBERT H. KIMBALL, In Charge, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January and February, 1924, **53:** 42 and 113.

From Table 1 it is seen that solar radiation intensities averaged slightly above the July normal at Washington, D. C., and Madison, Wis., and slightly below at Lincoln, Nebr. There were an unusual number of clear days at the first two stations.

Table 2 shows that the total solar and sky radiation received on a horizontal surface averaged above the July normal at Washington and Lincoln, and slightly below at Madison.

Skylight polarization measurements made on 14 days at Washington give a mean of 51 per cent, with a maximum of 69 per cent on the 18th. Measurements obtained on 10 days at Madison give a mean of 60 per cent, with a maximum of 70 per cent on the 1st. The values for Madison are close to the average values for July, and those for Washington are somewhat above.

TABLE 1.—*Solar radiation intensities during July, 1924.*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	[1]1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
July 7	19.89					1.37					19.23
10	19.23		0.59	0.72	0.93						16.20
11	13.13		0.56		0.98	1.27	0.99	0.79	0.65	0.51	11.38
12	18.59		0.51	0.71	0.84						18.59
14	12.68	0.50	0.65	0.83	1.02	1.32					11.38
16	16.20	0.37	0.47	0.61	0.80	1.15					16.20
17	15.65	0.57	0.63	0.75	0.95	1.18					12.83
18	9.83	0.83	0.92	1.05	1.19	1.41	1.08				8.48
21	16.79				0.76						16.70
23	19.23				0.98		1.10	0.91	0.78		14.60
24	14.10		0.71	0.81	0.95	1.23					13.61
26	10.97				1.12						9.14
28	11.81	0.57	0.67	0.78	0.97	1.20					12.24
29	14.10			0.59	0.91	1.16					14.10
30	15.65			0.48	0.72						13.13
Means		**0.57**	**0.63**	**0.73**	**0.94**	**1.25**	**1.06**	**(0.85)**	**(0.72)**	**(0.51)**	
Departures		**±0.00**	**−0.03**	**−0.03**	**+0.05**	**+0.08**	**+0.08**	**+0.06**	**+0.04**	**+0.13**	

The column heads 78.7° to 78.7° are the sun's zenith distance; the values under A. M. and P. M. are by air mass.

[1] Extrapolated.

TABLE 1.—*Solar Radiation intensities during July, 1924*—Cont'd.

[Gram-calories per minute per square centimeter of normal surface]

Madison, Wis.

Date	8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	A. M.					P. M.				Local mean solar time
	e	5.0	4.0	3.0	2.0	[1]1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
July 1	8.81			1.10	1.25						7.87
2	9.47		0.90	1.03	1.19	1.38					7.87
3	8.48			1.00	1.18	1.39					8.81
10	11.81				1.04	1.35	1.01				10.59
15	9.83				1.21	1.32					12.68
16	13.13				0.95						16.79
17	8.81				1.27	1.46					9.14
22	13.13				1.18	1.35					13.61
23	14.10				1.10	1.35					13.61
28	14.60				1.06						17.37
31	9.14					1.32					10.59
Means			**(0.90)**	**1.04**	**1.14**	**1.36**	**(1.01)**				
Departures			**+0.[illegible]3**	**+0.14**	**+0.10**	**0.09**	**+0.02**				

Lincoln, Nebr.

Date	e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e
July 3	8.48			0.91	1.12	1.38					6.02
7	8.56			0.62	0.78						9.14
10	10.59		0.84	0.99	1.20	1.43					8.48
12	14.10			0.98	1.11						16.79
14	10.59		0.69	0.86	0.92						9.83
15	13.13		0.76	0.90	1.06	1.28					15.65
23	15.11				1.08						19.89
25	10.97				1.24						9.14
26	12.24		0.80	0.93	1.09	1.27					12.68
30	16.79				0.99	1.24					21.28
Means			**0.77**	**0.88**	**1.06**	**1.32**					
Departures			**−0.03**	**−0.02**	**−0.02**	**−0.01**					

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

Week beginning—	Average daily radiation					Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Washington	Madison	Lincoln
1924	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
July 2	366	500	621	485	419	−116	−36	+43
9	577	552	623	419	516	+96	+32	+40
16	585	519	520	476	506	+110	+7	−51
23	601	467	625	447	540	+137	−23	+79
Excess or deficiency since first of year on July 29						+367	−7,078	+2,758

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The following table shows the average sea-level pressure for the month at a number of land stations on the coast and islands of the North Atlantic. The readings are for 8 a. m., 75th meridian time, and the departures are only approximate, as the normals were taken from the Pilot Chart and are based on Greenwich mean noon observations, which correspond to those taken at 7 a. m., 75th meridian time.

Station	Average pressure	Departures
	Inches	*Inches*
St. Johns, Newfoundland	29.87	−0.11
Nantucket	29.99	+0.02
Hatteras	30.02	+0.01
Key West	30.02	+0.01
New Orleans	30.03	+0.03
Swan Island	29.90	−0.02
Turks Island	30.09	+0.08
Bermuda	30.18	+0.08
Horta, Azores	30.25	−0.02
Lerwick, Shetland Islands	29.74	−0.07
Valencia, Ireland	29.98	−0.13
London	29.98	−0.08

It will be seen that fairly large negative departures occurred at St. Johns and Valencia, while at the remaining stations the pressure did not differ materially from the normal. At Horta the barometric readings ranged from 29.96 inches on the 9th and 11th to 30.50 inches on the 22d.

July is ordinarily the quietest month of the year over the North Atlantic, and the number of days with winds of gale force during the month under discussion did not differ materially from the normal as shown on the Pilot Chart. According to reports received, gales did not occur on more than two days in any 5-degree square or more than one day in any square south of the 40th parallel.

Fog, as in the two preceding months, was unusually prevalent over the ocean as a whole, with the exception of the immediate vicinity of the European coast. It was observed on 21 days on the banks of Newfoundland and on 19 days over the waters adjacent to the New England coast.

On the 1st there was a well-developed disturbance central about 300 miles west of the Irish coast, and vessels in the region between the 45th and 50th parallels and the 10th and 25th meridians reported moderate to strong gales. This LOW drifted slowly eastward, and from the 2d until the 7th remained in the vicinity of northern Europe. Storm logs:

American S. S. *Chester Valley*, Stettin to Galveston:

Gale began on the 1st, wind SW., 8. Lowest barometer 29.57 inches at 8 a. m., on the 1st, wind SW., 8, in 47° 28′ N., 15° 19′ W. End on the 1st, wind WNW., 6. Highest force of wind 8; shifts not given.

American S. S. *West Munham*, Rotterdam to New Orleans:

Gale began on the 2d, wind NW. Lowest barometer 29.54 inches at 7 a. m. on the 2d, wind NW., 5, in 49° 29′ N., 23° 25′ W. End on the 4th, wind WNW. Highest force of wind 8, NW.; shifts not given.

From the 4th to the 6th vessels in the North Sea encountered westerly to southwesterly gales, while moderate winds were reported by the European land stations. Storm log:

American S. S. *Ophis*, Malmo, Sweden, to Savannah:

Gale began on the 4th, wind SW., 8. Lowest barometer 29.34 inches, wind SW., 8, in 57° 36′ N., 10° 18′ E. End on the 4th, wind S. Highest force of wind 8, SW.; shifts SSW.-S.

On the 7th, St. Johns, Newfoundland, was near the center of a LOW that afterwards developed into the most severe disturbance of the month, reaching its greatest intensity on the 9th. Charts VIII to XI cover the period from the 8th to 11th, inclusive. From the 11th to 14th this LOW moved slowly eastward, losing in force, and on the latter date was in European waters, where it apparently remained for several days, although it was impossible to plot its course accurately on account of lack of observations. Storm logs:

Dutch S. S. *Merope*, Amsterdam to Curacao:

Gale began on the 7th, wind SW. Lowest barometer 29.65 inches on July 7, wind WNW., 8, in 41° 08′ N., 25° 40′ W. End on July 11th, wind W. Highest force of wind 8; shifts SW.-W.-NW.-W.

French S. S. *Britannia*, Marseilles to New York:

Gale began on the 7th, wind SSW. Lowest barometer 29.59 inches at 10 a. m. on the 8th, wind W., 8, in 40° 32′ N., 40° W. End on the 9th, wind NW. Highest force of wind 9, WNW.; shifts W.-WNW.

American S. S. *Vittorio Emmanuele III*, New York to Glasgow:

Gale began on the 7th, wind SW. Lowest barometer 29.27 inches at 8 a. m. on the 9th, wind WNW., 10, in 44° 58′ N., 39° 56′ W. End on the 10th, wind NW. Highest force of wind 10, WNW.; shifts NW.-WNW.-NW.

British S. S. *Kenbane Head*, Montreal to Dublin:

Gale began on the 8th, wind N. Lowest barometer 29.45 inches at 2 a. m. on the 9th, wind N., 8, in 54° N., 46° 30′ W. End on the 11th, wind NNW. Highest force of wind 8, N.; shifts N.-NNW.

On the 14th and 15th Newfoundland was surrounded by a slight disturbance, and on the latter date moderate southwesterly gales were reported from the region between the 35th and 40th parallels and the 55th and 60th meridians. Storm log:

American S. S. *Standard Arrow*, Calcutta to New York:

Gale began on the 15th, wind SW. Lowest barometer 30.04 inches at 1 p. m. on the 15th, wind SW., 7, in 38° 09′ N., 55° 52′ W. End on the 16th, wind NW. Highest force of wind 8, SW.; shifts SSW.-NW.

On the 18th a deep depression was central near Father Point, Quebec, although moderate weather prevailed over the ocean, with the exception of the region between the Bermudas and the 40th parallel, where moderate gales were encountered. Storm log:

British S. S. *Verentia*, London to New York:

Gale began on the 17th, wind S. Lowest barometer 29.55 inches on the 18th, wind S., 8, in 40° 55′ N., 62° 30′ W. End on the 18th, wind W. Highest force of wind 8; shifts S.-SW.-W.-NW.

From the 19th to 28th the weather over the ocean was comparatively featureless. A few vessels in widely-scattered positions reported moderate gales in their Greenwich mean noon observations, but no storm logs were rendered.

From the 23d to 30th the British S. S. *Maraval*, New York to Trinidad, experienced unusually heavy trade winds as shown by following report:

Very strong trade winds, reaching moderate gale force with squalls of terrific force were experienced. Heavy rains, overcast and cloudy weather. Barometer remaining normally steady;

ranged from 30.01 inches on the 23d to 30.19 on the 26th. Position at 8 a. m. on the 23d, 37° 43′ N., 72° 11′ W. At 8 a. m. on the 29th, 14° 54′ N., 62° 26′ W.

On the 29th there was a disturbance central near Hatteras that moved northeastward along the coast and on the 31st covered the region between Newfoundland and Nova Scotia; vessels in the southerly quadrants reported moderate to strong gales. Storm logs:

Italian S. S. *Clara*, Portugal to Philadelphia:

Gale began on the 29th, wind S. Lowest barometer 29.51 inches at 5 p. m. on the 29th, wind N., 9, in 37° 10′ N., 70° 15′ W. End on the 29th, wind NNE. Highest force of wind 9, N.; shifts S.-Calm-N.-NNE.

French S. S. *Rochambeau*, Havre to New York:

Gale began on the 30th, wind NE. Lowest barometer 29.63 inches from 6 to 12 a. m. on the 30th, wind NE., in 40° 59′ N., 66° 02′ W. End at 2 p. m. on the 30th. Highest force of wind 8; shifts NE.-N.

British S. S. *Aquitania*, Southampton to New York:

Gale began on the 31st, wind SSW. Lowest barometer 29.46 inches at 2.30 a. m. on the 31st, wind SSW., 10, in 41° 03′ N., 58° 40′ W. End at 6 a. m. on the 31st, wind W. Highest force of wind 10, SSW.; shifts SSW.-WSW.

NORTH PACIFIC OCEAN

By Willis Edwin Hurd

July, like the preceding month, was a period of few storms on the North Pacific. Along the entire northern sailing routes gales were rare and for the most part inconsequential. No gales were reported from mid-ocean, and the only severe disturbance of the month was a typhoon in the Far East. Only calms and light variable winds—northwesterly along the Mexican coast—seem to have occurred in lower southeastern tropical waters. At Honolulu the prevailing wind was from the east. The maximum wind velocity was at the rate of 29 miles an hour from the east, but on 8 other days the highest velocity equalled or exceeded 25 miles.

Mr. Joseph A. Stevens, observer on board the American S. S. *Java Arrow*, Shanghai to San Francisco, June 28 to July 15, thus commented upon the weather observed:

An unusually peaceful trip, wind not exceeding force 4, and sea not higher than moderate. During the greater part only a gentle westerly swell was experienced. The sky for the most part of the passage was overcast.

Mr. R. L. Frizzell, second officer of the American S. S. *Crosskeys*, eastward bound, noted the following:

The vessel remained nearly continuously in fog from July 1, in 44° 03′ N., 168° 30′ E., until July 7, in 49° 40′ N., 146° 10′ W. The fog was at times very heavy and at other times in drifting banks, accompanied by heavy mist.

Fog was frequent along the upper steamship lines, but occurred on the greatest number of days west and southwest of 176° E. over an area extending nearly to the Japanese coast. Fog was observed in Chinese waters on several days, and frequently in American coast waters between 50° and 30° N., diminishing southward to Cape San Lucas.

The eastern North Pacific high pressure area covered a great part of the central latitudes throughout July, and though it fluctuated in position of crest and in intensity, was little disturbed internally by cyclonic influences. Occasional gales, however, blew on its northern and eastern borders, due in the one case to the sporadic presence of the Aleutian cyclone, and in the other to the proximity of the fairly well settled continental depression over the western region of the United States.

The Aleutian low, as such, was as a whole rather feebly defined. It was central on a few days near or to the westward of Dutch Harbor; on a few days over southern Alaska or the northern part of the adjoining gulf; and in considerably higher latitudes during the major part of the month.

Reports from Dutch Harbor were interrupted during the early part of July and it is impossible to give the average pressure for the month. The average for 20 days was 29.94 inches, whereas the July normal is 30.02, the highest monthly normal of the year. The highest pressure reported was 30.34, on the 24th and 26th; the lowest, 28.94, on the 18th. At Midway Island pressure was higher than in any previous July of record, being 30.19, or 0.12 inch above the average of 13 years, including the current one. Also, it was above the average on every day at the hour of observation. The highest reading was 30.28, on the 1st, 2d, 17th, and 18th; the lowest, 30.10, on the 26th and 27th. Pressure at Honolulu was also above normal, being deficient on only two days and equal to the normal on one. The average p. m. pressure of the month was 30.06, or 0.05 inch above normal. The highest pressure was 30.15, occurring on the 16th; the lowest, 29.94, on the 25th.

Low pressure covered the China coast and adjacent waters. This condition was similar to that of June, but cyclonic activity was greater in July, and at least one fully developed typhoon raged over the Eastern Sea.

This typhoon seems to have originated northwest of Guam about the 5th. The initial depression moved west, then turned into northwest, gaining energy until the 11th, when it was reported in a typhoon warning received by the Norwegian S. S. *Storviken* as "at noon in 24° N., 126° E., depth 28.19, direction NW." The *Storviken* at and near that time was close to 32° N., 131° E., experiencing the following weather:

Partly cloudy, strong easterly wind forenoon, after southeasterly, force 5, sea rough, south swell.

On the 11th the American steamer *West Islip*, Hongkong to San Francisco, ran into the storm. At 2 a. m. (local time), while near 28° N., 125¼° E., "the wind shifted to NE. 5-6, barometer 29.50, rough ENE. sea." Sometime during the day the wind went into north with full hurricane force and pressure rapidly falling to the observed minimum of 28.40. At 8:23 p. m., in 28° 25′ N., 125° 40′ E., the wind was WSW. 9, and at midnight SW. 10, pressure 28.90, rough cross sea. At 2 a. m. of the 12th the southwest gale increased to force 11, then gradually diminished, with rising barometer.

The American S. S. *India Arrow*, Swatow to San Francisco, rode out the worst of the typhoon during the night of the 13th-14th. At 8:20 p. m. of the 13th, in 26° 15′ N., 124° 40′ E., she experienced a moderate NNE. gale, pressure 29.67. At 2:45 a. m. of the 14th the wind changed to east and rose to a hurricane, pressure 29.31, in 26° 40′ N., 124° 45′ E. By 8 a. m. the worst of the storm was over, the wind coming into ESE. and the force diminishing to 8.

On the 26th and 27th a depression lay west of Guam, and on the 30th and 31st extended over the northern Philippines and Taiwan. It concentrated in area and probably in energy on August 1, moved northward east of Taiwan, and for several days was a weather factor in Far Eastern waters, though at this writing little is known of its strength.

Coming into that part of the ocean east of the 180th meridian, the westernmost gales encountered were southeast squalls at and near Dutch Harbor on the 20th during

the period of greatest intensity of the Aleutian LOW. Moderate to fresh gales occurred in the Gulf of Alaska on several days—at the head of the gulf on the 8th, 10th, 11th, 17th, and 18th, as observed by the American S. S. *Northwestern;* and over the south-central and eastern portions on the 1st, 8th, and 22d. The Aleutian offshooting LOW which caused the gales on the 8th passed into the Canadian Northwest on the 9th.

Northwest gales occurred near the coast of California on the 5th and 6th, and rising as they did to a force of 10, as noted by the American S. S. *H. F. Alexander*, constituted the strongest winds of the month outside of the Tropics. Moderate northeast gales also occurred near the same coast on the 21st, and farther at sea on the San Francisco-Hawaii route on the 20th and 22d.

INDIAN AND SOUTH PACIFIC OCEANS

By ALBERT J. MCCURDY, JR.

Arabian Sea.—Weather reports received from vessels that crossed the Arabian Sea during July indicate a moderate activity of the southwest monsoon in that month. The average wind force was 5, and moderate to fresh gales were experienced on somewhat more than one-fourth of the days.

The Dutch S. S. *Menado*, Capt. R. Borst, Suez to Colombo via Djibouti, encountered on the 6th a moderate southwesterly gale accompanied by high seas. Mr. W. J. Klijn, observer, reports that the lowest pressure observed was 29.66 inches (uncorrected), occurring at 3:40 p. m., in 12° 37′ N., 55° E. The wind at this time was SW. by S., force 7, and decreased by 10 p. m. to a fresh SW. breeze.

On the same date the British S. S. *Suncliff*, Capt. H. J. Case, Colombo to Port Sudan, encountered a southwesterly gale in 5° 51′ N., 52° 28′ E. Mr. A. Horey, third officer, states that the lowest barometer, 29.83 inches, was recorded about 3 p. m. on the 6th. The wind at this time was SW., force 7, thence increased to a fresh gale on the following day, accompanied by high confused seas that lasted until 1 a. m. of the 8th.

From the 15th to 18th the British S. S. *Slavic Prince*, Capt. C. W. Chambers, Penang to Aden, experienced southwesterly winds of force 7 to 8, accompanied by very heavy seas. Mr. W. C. Freeman, second officer, states that the lowest barometer recorded was 29.64 inches (uncorrected), occurring at 3:45 p. m., on the 18th, in 12° 54′ N., 57° 15′ E.

On the 23d the Dutch S. S. *Kawi*, Capt. E. P. Ross, Sabang to Perim, experienced a southwesterly gale south of Sokotra, reporting conditions similiar to those experienced by the *Slavic Prince*. The lowest pressure was 29.73 inches (uncorrected), occurring at 4 p. m., on the 23d in 10° 30′ N., 51° 22′ E. At this time the wind was SW., force 7, gradually shifting toward the south.

South Pacific Ocean.—The only gale of any consequence reported in the South Pacific for this month was a disturbance in the vicinity of New Zealand that appeared on July 21, and which until the 26th occasioned moderate to strong gales with accompanying high seas. The British S. S. *Orowaiti*, Capt. W. H. Smith, Wellington to San Luis Obispo, came within its influence on the 21st. The observer, Mr. C. R. Smith, is quoted as follows:

> Gale commenced in early morning of the 21st and increased till midnight. Wind shifted from S. to SW., after rounding Cape Palliser. Wind just blew itself out.
>
> 23d–25th. The worst and heaviest wind and sea were experienced between 4 and 8 a. m., on the 25th, which was sometime after lowest barometer. There were no sudden changes of wind.

The lowest barometer recorded was 29.52 inches, occurring at 4 p. m. on the 24th, in 29° S., 172° 51′ W. The wind at this time was northerly, force 9. The gale lasted throughout the evening of the 25th, and during that time the wind shifted to the SW.

From the 24 to 26th this same gale was experienced by the British S. S. *Maunganui*, Capt. L. C. H. Worsall, Wellington to Rarotonga. Mr. W. Johnson, observer, reports that the lowest barometer noted was 29.47 inches (uncorrected), occurring at 2 p. m. on the 24th, in 31° 31′ S., 171° 40′ W. The wind at this time was SE., force 8, later shifting to NW., thence to W. by S., force 8, with a steadily rising barometer.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

By ALFRED J. HENRY

Anticyclones (HIGHS) that drifted slowly across the continent toward the southeast appeared to dominate the weather of the month in the great majority of districts. As a whole, the month was cool and dry, although areas in Florida, the lower Mississippi Valley, and the northern Rocky Mountain Plateau had above-normal temperature. The rainfall was irregularly distributed; more than the normal fell along the Atlantic coast south of the Virginia capes, also locally in the Lake region and the middle Mississippi Valley. In general, however, the rainfall in the great majority of localities was below the normal, the shortage being especially noticeable in the lower Mississippi Valley and the western Gulf States. The usual details follow:

CYCLONES AND ANTICYCLONES

By W. P. DAY

The general movement of the centers of cyclones during the month of July was eastward across the northern United States, and Canada (within the limits of observation). However, the low-pressure systems crossing the field of observations were mostly of the trough formation and sometimes without the usual accompanying cyclonic circulation. The weather over the Southern States was entirely dependent on the day-to-day displacements of these troughs or lines of discontinuity.

The anticyclones, on the other hand, were generally more prominent and retained their identities over considerable periods, notably the Alberta HIGHS which were on the weather chart at the beginning and at the end of the month.

FREE-AIR SUMMARY

By V. E. JAKL, Meteorologist

The average free-air conditions for the month, as determined by kites and given in Tables 1 and 2, showed, with no important exceptions, close agreement with the normal for all sections of the country represented by the six fully equipped aerological stations. The most noticeable departure is in temperature, in which respect the month was generally slightly cooler than normal, although the departures were not of a decided nature ex-

cept over the northern stations. At Drexel, Ellendale, and Royal Center, the departure varied between 1° and 2° C. below normal at all levels for which reliable averages were obtained.

While no important departures are noted for any station, interest attaches to a comparison of the records at the different stations, particularly in relation to the surface weather conditions that prevailed. The records of two adjoining stations, viz, Broken Arrow and Groesbeck, may be cited as an example. Upper-air conditions undoubtedly bore some relation to the wide divergence in the precipitation recorded at these stations. Frequent thunderstorms and considerable precipitation at Broken Arrow was in marked contrast to the weather prevailing at Groesbeck, 300 miles to the south, where measurable amount of rain fell on only one day. The tabulated data indicate that important differences prevailed between the free-air wind resultants and average humidities over these two stations. A more westerly component in the upper levels is shown over Broken Arrow than over Groesbeck, although it is more pronounced in the pilot balloon observations, as the resultants for the higher levels shown in Table 2 are based on but few kite observations. The somewhat opposed winds at the two stations and their greater strength at Broken Arrow may be attributed to the fact that Groesbeck was largely under the influence of stagnant HIGHS during the month, while Broken Arrow frequently lay in the path of LOWS and moving HIGHS, which, however, did not extend their influence to the Gulf. The significance of the humidity records appears to lie in the average low values found over Groesbeck in all but the lower levels, while on the other hand high humidities were prevalent over Broken Arrow at all levels.

The following table, showing a comparison of upper-air observations at Broken Arrow and Groesbeck on the 18th, has been selected as typical of a number of days on which precipitation occurred at Broken Arrow, and kite flights were made nearly simultaneously at both stations. In the record of the observation at Broken Arrow, made soon after the occurrence of heavy precipitation, it will be noted that the wind veered and increased in strength with altitude, and that there was a practically unbroken lapse rate in temperature. Also, the humidity averaged high in the various strata. At Groesbeck the winds were uniformly from a southerly direction, and generally of light to moderate force, while an inversion in temperature at a moderate altitude coincided with an abrupt change to low humidity that prevailed to the upper limit of observation. These conditions at the two stations can be reconciled with their respective positions relative to surrounding pressure distribution. The upper-air conditions and precipitation at Broken Arrow were characteristic of its position relative to a fairly well defined LOW, being successively to the east and south of the trough center. The effects of this LOW did not penetrate south to Groesbeck, which was under the influence of a dormant HIGH. In fact, the free-air conditions observed at Groesbeck on this date were quite typical of the month, as will be noted by comparing with the averages for that station given in Tables 1 and 2. Furthermore, as the dryness of the month noted at Groesbeck with its accompanying pressure conditions extended over the West Gulf region it is probable that the average upper-air conditions at Groesbeck during the month are characteristic of moderate altitudes in the rear of stagnant HIGHS.

Meteorological conditions over Broken Arrow, Okla., and Groesbeck, Tex., on July 18, 1924

Station and time	Altitude, m. s. l.	Temperature	Relative humidity	Wind direction	Wind velocity
	meters	°*C.*	*Per cent*		*m. p. s.*
Broken Arrow:					
10:01 a. m	[1] 233	24.4	93	SSE	9
10:03 a. m	522	23.1	93	SSE	17
10:08 a. m	656	24.0	67	SSE	12
10:27 a. m	1,728	19.4	61	SSW	10
10:58 a. m	3,415	8.2	100	W	14
11:08 a. m	4,219	3.1	65	WSW	20
11:16 a. m	4,430	1.6	81	WSW	16
Groesbeck:					
10:07 a. m	[1] 141	30.3	57	SSW	8
10:15 a. m	607	25.1	75	SSW	9
10:34 a. m	1,409	18.6	91	SSW	11
10:44 a. m	1,852	19.3	44	SSW	6
11:15 a. m	2,211	18.5	40	SSW	6
11:41 a. m	3,328	11.1	31	SSW	8

[1] Surface.

A good illustration of the effects of pronounced vertical currents is given in the kite and double theodolite pilot balloon observations made at Ellendale on the 14th, which on that date was situated on the north edge of a high pressure area. The balloon observation, which extended to 5,000 meters altitude in a general westerly wind, showed marked convectional activity in the lower half of the air column. By comparing the actual ascensional rate of the balloon with the standard rate to which it was inflated, it was found that in the lower 2,400 meters it was carried along in a column of ascending air that had an average vertical velocity of 2.7 meters per second, with a maximum velocity about midway of this column of approximately 5.3 meters per second. Above 2,400 meters the ascensional rate of the balloon was retarded for a few hundred meters, but thereafter to the upper limit of observation the standard ascensional rate obtained. A kite flight made a few hours earlier, the record of which is given in the following table, showed increasing humidity from the ground up to the level of cumulus clouds at about 2,100 meters from the surface, above which much drier air prevailed.

Meteorological conditions over Ellendale, N. Dak., on July 14, 1924

Time	Altitude m. s. l.	Temperature	Relative humidity	Wind direction	Wind velocity
	Meters	°*C.*	*Per cent*		*m. p. s.*
10:17 a. m	3,557	3.1	27	WNW	8
10:31 a. m	2,836	6.5	21	WNW	7
10:34 a. m	2,493	5.4	89	WNW	7
10:54 a. m	1,826	9.6	73	WSW	7
11:21 a. m	836	18.6	48	WSW	8
11:28 a. m	[1] 444	26.0	42	SW	5

[1] Surface.

An illustration of the opposite effect of convectional action on a pilot balloon is given in the double theodolite observation made at Broken Arrow on the 10th, on which date Broken Arrow lay to the southwest of a high-pressure area. This observation showed a rather uniform ascensional rate of 42 meters per minute less than the standard inflation rate, up to 2,200 meters from the surface, above which the balloon ascended at slightly more than the standard rate. This retardation of the ascensional rate in the lower air column indicated a descending current of about 0.7 meter per second, or 1.6 miles per hour which was undoubtedly of a convectional nature, as the indicated rate was too large to be attributed to the descent of air resulting from the assumed outflow from

the HIGH. This example and the one previously given well illustrate the vertical convectional exchange of air typical of cumulus cloud formation. A commentary on these observations is that rising currents are much more frequently observed in double theodolite observations than descending currents, due to the fact that the latter are usually too weak to be definitely revealed in the records of observations. This leads to the conclusion that ascending currents are almost invariably smaller in cross section than their compensatory descending currents. In the observation last cited the winds in the lower levels embraced by the downard current were light easterly, above which they shifted abruptly to westerly, and finally to northwesterly in the very high altitudes. A velocity of 37 meters per second, or 83 miles per hour, was recorded at 11,500 meters, which was the highest velocity reported during the month in the observations of any pilot balloon station.

A pilot-balloon observation made at Broken Arrow on the 23d exceeded every previous record for length of time a balloon was followed by two theodolites, and with one exception, was a record in the United States for altitude to which a pilot balloon has been definitely known to ascend. This observation showed the balloon to have steadily ascended to 16,000 meters at a rate that for the most part agreed approximately with the standard or normal ascensional rate. At this altitude the balloon evidently became defective, as further observation showed an irregular rise and fall of the balloon for a prolonged period. The winds throughout this depth of altitude were general westerly of light velocity.

Winds at high altitudes having a decided easterly component were observed at most northern stations with more or less frequency from the 2d to the 6th. Over the most southerly stations easterly winds were frequent enough to give an east component at various altitudes in the resultants for the month. At Key West and San Juan there was a strong easterly component throughout the month for all levels represented by sufficient observation; while at Groesbeck the afternoon observations showed a decided northeasterly component at all levels above 5,000 meters. Over both the northern and the southern stations the easterly winds appear to have been associated with stationary or slow moving high-pressure areas. A high-pressure area that approached from the Canadian Northwest toward the last of June drifted slowly over the Eastern States during the first decade of July, with which fact may be connected the easterly winds observed whenever high altitudes were reached at the northern stations during the first few days of the month. Over the Gulf States a condition of moderately high pressure persisted, with but little interruption, throughout the month.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during July, 1924*

TEMPERATURE (°C.)

Altitude m. s. l. (m.)	Broken Arrow, Okla. (233 m.) Mean	Departure from 6-yr. mean	Drexel, Nebr. (396 m.) Mean	Departure from 9-yr. mean	Due West, S. C. (217 m.) Mean	Departure from 4-yr. mean	Ellendale, N. Dak. (444 m.) Mean	Departure from 7-yr. mean	Groesbeck, Tex. (141 m.) Mean	Departure from 6-yr. mean	Royal Center, Ind. (225 m.) Mean	Departure from 7-yr. mean
Surface	26.6	−0.3	21.8	−2.9	25.7	−1.0	20.1	−1.2	26.0	−0.7	23.7	−1.7
250	26.5	−0.3	------	------	25.4	−1.0	------	------	25.1	−0.7	23.3	−1.8
500	24.9	−0.3	21.6	−2.6	22.9	−1.1	19.6	−1.4	23.1	−0.8	20.3	−2.3
750	23.3	−0.4	20.6	−2.3	21.2	−1.0	18.1	−1.6	21.7	−1.0	18.7	−2.0
1,000	21.9	−0.3	19.7	−1.8	19.6	−0.8	17.1	−1.4	20.8	−0.8	17.0	−2.0
1,250	20.2	−0.4	18.5	−1.6	18.0	−0.7	16.0	−1.4	19.7	−0.6	15.4	−2.0
1,500	18.8	−0.2	17.3	−1.3	16.1	−0.9	14.6	−1.7	18.5	−0.4	13.8	−2.0
2,000	15.8	0.0	14.5	−1.0	12.8	−1.1	11.6	−2.0	16.6	+0.3	11.5	−1.5
2,500	12.7	+0.1	11.9	−0.4	9.3	−1.5	8.5	−2.1	14.4	+0.8	8.7	−1.6
3,000	9.5	+0.1	9.0	0.0	5.8	−1.9	6.2	−1.5	12.1	+1.2	5.8	−1.6
3,500	7.1	+0.5	6.2	+0.6	2.5	−2.0	3.5	−1.2	9.4	+1.5	1.9	−2.5
4,000	3.9	+0.5	3.8	+1.3	0.1	−1.5	0.5	−1.6	7.0	+2.2	------	------
4,500	0.8	+0.1	−0.7	+0.1	−1.4	−0.4	−1.5	−1.1	6.6	+3.4	------	------
5,000	−1.9	+0.1	------	------	------	------	−3.7	−0.6	4.6	+3.8	------	------

RELATIVE HUMIDITY (%)

Altitude m. s. l. (m.)	Broken Arrow Mean	Departure	Drexel Mean	Departure	Due West Mean	Departure	Ellendale Mean	Departure	Groesbeck Mean	Departure	Royal Center Mean	Departure
Surface	67	−2	69	+4	67	0	60	−10	71	−3	69	+7
250	67	−2	------	------	67	0	------	------	72	−3	69	+7
500	64	−2	65	+2	70	+1	60	−9	73	−2	69	+5
750	64	−1	61	+1	72	+1	58	−6	70	0	69	+3
1,000	65	0	59	0	74	+1	55	−7	63	−3	73	+6
1,250	67	+1	58	0	76	+1	54	−6	59	−5	74	+7
1,500	66	0	55	−2	78	+4	55	−3	57	−6	74	+7
2,000	65	+1	55	0	79	+6	57	+1	51	−10	64	+2
2,500	66	+4	52	−1	80	+7	53	−1	48	−11	66	+9
3,000	66	+6	53	+1	78	+6	42	−9	48	−10	62	+9
3,500	62	+4	51	−1	79	+10	37	−14	52	−6	63	+15
4,000	56	+1	42	−8	75	+13	33	−18	46	−14	------	------
4,500	57	+6	46	−6	61	+10	24	−32	19	−17	------	------
5,000	62	+6	------	------	------	------	16	−35	17	−16	------	------

VAPOR PRESSURE (*mb.*)

Altitude m. s. l. (m.)	Broken Arrow Mean	Departure	Drexel Mean	Departure	Due West Mean	Departure	Ellendale Mean	Departure	Groesbeck Mean	Departure	Royal Center Mean	Departure
Surface	23.30	−0.89	18.16	−1.80	21.50	−1.64	13.97	−3.51	23.76	−1.79	20.36	+0.50
250	23.06	−0.90	------	------	21.23	−1.54	------	------	23.02	−1.56	19.89	+0.30
500	20.03	−0.90	17.10	−1.83	19.18	−1.08	13.53	−3.38	20.79	−1.36	16.57	−0.73
750	18.13	−0.61	15.22	−1.49	17.89	−0.78	11.97	−2.62	18.06	−1.22	14.99	−0.63
1,000	16.76	−0.34	13.94	−1.22	16.71	−0.56	10.72	−2.33	15.33	−1.52	14.25	−0.09
1,250	15.58	−0.02	12.73	−1.05	15.72	−0.22	9.74	−1.94	13.41	−1.63	12.92	0.00
1,500	14.19	+0.14	11.23	−1.17	14.30	+0.12	9.14	−1.25	11.99	−1.63	11.53	−0.05
2,000	11.57	+0.44	9.31	−0.62	11.54	+0.10	7.74	−0.66	9.57	−1.64	8.27	−0.47
2,500	9.31	+0.52	7.26	−0.58	9.11	−0.16	5.97	−0.88	7.91	−1.30	7.10	+0.63
3,000	7.38	+0.52	6.05	−0.07	6.87	−0.55	4.06	−1.38	6.88	−0.82	5.68	+0.71
3,500	5.95	+0.43	4.37	−0.39	5.64	+0.07	3.04	−1.47	6.05	−0.38	4.34	+0.61
4,000	4.04	−0.01	3.07	−0.62	4.49	+0.53	2.42	−1.31	4.57	−0.82	------	------
4,500	3.47	+0.48	2.36	−0.68	3.24	+0.48	1.87	−1.68	2.68	−0.69	------	------
5,000	3.25	+0.48	------	------	------	------	1.43	−1.72	2.44	−0.83	------	------

TABLE 2.—*Free-air resultant winds (m. p. s.) during July, 1924*

Altitude, m. s. l. (m.)	Broken Arrow, Okla. (233 meters)				Drexel, Nebr. (396 meters)				Due West, S. C. (217 meters)			
	Mean		6-year mean		Mean		9-year mean		Mean		4-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 7° W.	4.1	S. 1° W.	3.2	S.	1.6	S. 1° W.	2.2	N. 22° E.	1.3	S. 67° W.	1.0
250	S. 7° W.	4.3	S. 1° W.	3.3	------	----	------	----	N. 17° E.	1.3	S. 69° W.	1.1
500	S. 15° W.	7.3	S. 11° W.	4.7	S. 7° E.	2.4	S. 3° W.	3.0	N. 5° W.	1.4	S. 78° W.	1.7
750	S. 18° W.	7.9	S. 20° W.	5.1	S. 4° E.	3.5	S. 16° W.	4.2	N. 20° W.	1.2	S. 87° W.	2.2
1,000	S. 27° W.	7.9	S. 27° W.	4.9	S. 14° W.	3.8	S. 24° W.	4.5	N. 46° W.	1.9	N. 88° W.	2.4
1,250	S. 28° W.	7.6	S. 31° W.	4.8	S. 28° W.	4.1	S. 35° W.	4.6	N. 74° W.	3.0	S. 83° W.	2.6
1,500	S. 37° W.	7.4	S. 35° W.	4.8	S. 44° W.	4.4	S. 42° W.	4.4	N. 78° W.	4.4	S. 85° W.	3.8
2,000	S. 43° W.	5.5	S. 35° W.	4.0	S. 53° W.	5.1	S. 55° W.	5.0	N. 89° W.	9.4	S. 84° W.	5.1
2,500	S. 58° W.	5.4	S. 46° W.	4.2	S. 70° W.	6.0	S. 70° W.	5.4	N. 86° W.	9.7	S. 87° W.	5.9
3,000	S. 68° W.	4.9	S. 58° W.	4.7	S. 72° W.	5.9	S. 70° W.	6.3	N. 81° W.	8.2	S. 87° W.	7.5
3,500	S. 85° W.	4.9	S. 70° W.	4.8	S. 78° W.	6.8	S. 72° W.	7.3	N. 84° W.	7.9	N. 89° W.	7.3
4,000	S. 54° W.	12.1	S. 55° W.	8.2	S. 86° W.	11.1	S. 76° W.	7.4	N. 81° W.	8.2	N. 79° W.	7.6
4,500	S. 47° W.	13.8	S. 37° W.	10.9	N. 62° W.	11.7	S. 66° W.	7.7	W.	8.2	W.	8.6
5,000	S. 22° W.	14.2	S. 10° E.	11.4	------	----	------	----	W.	7.3	W.	7.4

Altitude, m. s. l. (m.)	Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)			
	Mean		7-year mean		Mean		6-year mean		Mean		7-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 30° W.	0.7	S. 13° E.	0.2	S. 17° W.	3.1	S. 19° W.	3.3	N. 88° W.	2.0	S. 81° W.	1.6
250	------	----	------	----	S. 16° W.	3.8	S. 21° W.	4.2	S. 88° W.	2.1	S. 80° W.	1.8
500	S. 16° W.	1.5	S. 10° E.	0.6	S. 13° W.	5.2	S. 28° W.	5.8	S. 61° W.	4.0	S. 71° W.	3.2
750	S. 27° W.	2.7	S. 11° W.	1.5	S. 10° W.	5.8	S. 29° W.	5.8	S. 61° W.	4.7	S. 70° W.	4.0
1,000	S. 46° W.	3.2	S. 36° W.	2.0	S. 12° W.	5.9	S. 30° W.	5.5	S. 61° W.	5.1	S. 74° W.	4.6
1,250	S. 57° W.	3.5	S. 52° W.	2.3	S. 17° W.	5.3	S. 32° W.	5.2	S. 66° W.	5.4	S. 79° W.	5.2
1,500	S. 65° W.	3.9	S. 62° W.	2.9	S. 16° W.	5.1	S. 31° W.	4.8	S. 78° W.	7.5	S. 83° W.	5.9
2,000	S. 76° W.	4.7	S. 79° W.	4.3	S. 17° W.	3.7	S. 32° W.	3.9	S. 89° W.	9.3	S. 86° W.	7.0
2,500	S. 87° W.	6.1	N. 89° W.	5.9	S. 22° W.	3.3	S. 31° W.	3.5	N. 80° W.	10.9	W.	9.4
3,000	S. 85° W.	7.9	W.	7.6	S. 30° W.	3.1	S. 26° W.	3.4	N. 72° W.	13.2	S. 87° W.	11.7
3,500	N. 87° W.	9.0	N. 79° W.	9.6	N. 69° W.	3.8	S. 19° W.	1.9	W.	11.3	S. 83° W.	11.3
4,000	N. 79° W.	10.3	N. 72° W.	10.8	N. 36° W.	7.5	N. 55° W.	1.0	W.	17.5	N. 76° W.	9.5
4,500	N. 45° W.	15.2	N. 64° W.	13.1	N. 22° W.	8.7	N. 25° E.	5.5	------	----	------	----
5,000	N. 45° W.	17.5	N. 67° W.	16.0	N. 23° W.	8.8	N. 35° E.	2.9	------	----	------	----

THE WEATHER ELEMENTS

By P. C. Day, Meteorologist, in Charge of Division

PRESSURE AND WINDS

The month as a whole was notably free from extensive cyclonic storms (see Chart II). In fact no single storm area of sufficient importance to cause continued precipitation moved over any extensive path. Numerous low-pressure areas attended by more or less rainfall appeared on the daily weather maps, but they persisted for short periods only, save from about the 15th to 21st, when moderately low pressure was maintained in the Middle Plains region, attended by local precipitation. Anticyclones were the dominant feature of the atmospheric circulation, although these were mainly of unimportant character save in their influence toward lower temperatures.

The month opened with high pressure central over the middle Missouri Valley, and as it moved slowly southward and eastward gave the coolest weather of the month over the central valleys and most southern districts. This was soon followed by another which moved from the far Northwest and was central over the Southern Plains at the end of the first decade, moving thence into the Southeastern States during the following few days. The next important high-pressure area entered the far Northwest about the beginning of the last decade, and, as it moved southeastward over the Plateau and Rocky Mountain regions, brought unseasonably low temperatures to those districts. At the end of the month high pressure, moving from the Canadian Northwest toward the Great Lakes, brought moderately cool weather over most northern districts.

On account of the predominance of anticyclonic conditions the average pressure for the month was slightly above the normal in practically all parts of the country. Small areas in the northern Plateau and northern Rocky Mountain regions, in the Southeast, and in the New England States had averages slightly below normal. Compared with June the average pressures were nearly everywhere materially higher, this being particularly so over the Middle Plains and adjacent areas.

Barometric gradients were mainly shallow, and high winds were associated usually with local thunder or other storms, which were generally far less severe than during the preceding month. Likewise the moderately even distribution of the average pressure over the various portions of the country tended toward frequent variations in the prevailing directions of the winds, though over the Great Plains and Mississippi Valley they were largely from the south.

TEMPERATURE

The outstanding feature of the weather during July, 1924, was the further continuation of unseasonably cool weather (see Chart IV), which had been so persistent during the two preceding months, particularly over the northern and central districts from the Rocky Mountains eastward.

The temperature averages for each week in the month were below normal over large areas of the region referred to above, and in some instances nearly the entire country from the Rocky Mountains eastward experienced temperatures unusually low for midsummer.

The coldest period generally was the first week, when temperatures frequently 10° to 15° below the normal prevailed over the central valleys and southern districts, and all sections from the Rocky Mountains eastward had temperatures during this period almost continuously below normal, save over a small area from northern Minnesota westward to Montana, and in northern New England. At the same time decidedly warm weather continued in the far West, as had been the case during much of the two preceding months.

The second week experienced a moderate reaction to more nearly normal conditions, though the week as a whole continued cooler than normal from the Rocky Mountains eastward, save in the extreme South and along the immediate Atlantic coast. In the far West temperature conditions moderated somewhat and the week as a whole was slightly cooler than normal over the southern districts, but mainly slightly warmer over the northern portions.

The week ended July 22 was, in the main, distinctly cool over the greater part of the country, though some high temperatures prevailed locally in the Northwest and Southwest, and the warmest weather of the month was observed over many southern districts at the close. In the far West the long continued heated period was definitely broken, and the week as a whole was moderately cool, affording much relief.

The period from the 23d to the end of the month brought frequent changes in temperature, with the highest readings of the month over much of the country from the Mississippi Valley eastward, and the lowest temperatures in some of the far Western States, and in portions of New York and New England. The period as a whole continued materially warmer than normal in the Southern States from Texas and Oklahoma eastward, and it was moderately warmer than usual over much of the Plateau region and far Northwest. In the central and northern districts from the Rocky Mountains eastward the week as a whole was moderately cool, and like conditions prevailed over most of California and the Southwest.

Maximum temperatures above 100° occurred during the month in all the States save from the Great Lakes and Ohio Valley eastward. The highest reported, 124°, occurred in California.

Minimum temperatures below freezing were reported from a few points near the northern border, and at the higher elevations of the western mountain districts, the lowest, 17°, occurring in the mountains of Idaho. The minimum temperatures during the first two or three days of the month were the lowest, or among the lowest of record for July at many points in the lower Mississippi Valley and adjacent areas of the Gulf States.

For the month as a whole, as previously stated, the average temperature was again well below normal over all central and northern districts from the Rocky Mountains to the Great Lakes and Middle Atlantic States, and it was slightly cooler than normal over most other portions of the country, the only sections appreciably warmer than normal being small areas in the New England States, the Florida Peninsula, and lower Mississippi Valley, a few points in Arizona and generally over the far Northwest.

PRECIPITATION

July was a dry month over much of the country, though such precipitation as occurred was moderately well distributed during the various periods of the month. No day in the month was without material rainfall in

some portion, but the dates on which precipitation was most widespreau and in greatest volume were the 8th to 10th, 13th to 14th, 17th to 19th, and on the 31st.

Precipitation was greatly deficient in most of the Southern States, particularly from western Alabama to Arkansas and central Texas, the month being the driest July of record at points in eastern Texas, and among the driest of record at points in Louisiana. Over much of Florida and locally in Georgia, eastern Alabama, and the coast districts of the Carolinas the monthly amounts were above normal, in some cases far above, due to heavy falls on a few days rather than to any excess of rainy days.

Precipitation was largely deficient from central Virginia to southern New England, the total falls in portions of the latter section amounting to less or only slightly more than half an inch. There was likewise a large deficiency in the lower Ohio Valley, and in portions of Iowa and the northern Plains.

Dry weather continued in most districts from the Rocky Mountains westward, save in portions of the northern Rocky Mountain and Plateau regions, where locally there were some good rains. In the Pacific coast States drought continued, though of course rain is not expected at this season of the year. However, the absence of the usual falls earlier in the season has resulted in a greatly reduced supply of water. Stream flow continued the lowest of record, particularly in California, and old wells were dug deeper and new ones opened to alleviate the water shortage. Hydroelectric plants were unable to deliver the required amount of power, and auxiliary steam plants were operated everywhere to augment the output.

On account of the continued drought in the far West and the dry and heated condition of the forests, the fire hazard was greatly increased and forest fires were frequent, and in many cases hard to control.

SNOWFALL

An unusual fall of snow was reported from the high elevations of the Yellowstone Park locality on the 20th, where depths of 4 to 6 inches occurred, continuing for a period of nearly 24 hours.

RELATIVE HUMIDITY

The extreme drought conditions existing during the month in the lower Mississippi Valley and adjacent portions of Texas were attended by a marked deficiency in the percentage of relative humidity in that section as compared with the normal, and similar conditions existed in most districts from the Rocky Mountains westward. In other parts of the country the departures from normal were not unusual.

The month was distinctly lacking in sunshine in portions of the Southeastern States, notably in Florida and southern Georgia, and less so in the southern Appalachian Mountains. Elsewhere there was mainly abundant sunshine, and it was almost continuous in the Great Valleys of California and in western Arizona.

SEVERE LOCAL HAIL AND WIND STORMS, JULY, 1924

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path [1]	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Richards, Colo	1	4 p. m	8,800		$10,000	Heavy hail	Roofs damaged; chickens killed	Official, U. S. Weather Bureau.
Los Lunas, N. Mex	1	6-6:30 p. m	2 mi		10,000	do	Damage chiefly to crops	Do
Hooker, Okla	1					do	Large area of fine wheat total loss	Do.
Stead (near), N. Mex	1	3 p. m	10 mi		10,000	do	Character of damage not reported	Do.
Stevens County, Kans	1	4 p. m	3-7 mi			Hail	Very destructive storm; 30,000 acres of wheat ruined; other crops beaten; path 40 miles long.	Do.
Winsors, N. Mex	2	4 p. m	3 mi			Heavy hail	Roofs and gardens damaged	Do.
Dimmitt, Tex	3	8:15 p. m	8 mi		500,000	Hail	Total loss of crops	Do.
Landrum, S. C	4					do	Moderate damage	Do.
Livonia, N. Y	5	3:30 p. m	7,040			Heavy hail and rain.	Orchards, vineyards, and buildings damaged; grain injured; telephone and telegraph poles down.	Official, U. S. Weather Bureau; Rochester Herald (N. Y.).
Lake County, Ill. (w. and sw. of Grayslake).	7	2 p. m	2-3 mi			Hail	Considerable crop damage	Official, U. S. Weather Bureau.
Burlington, Wyo	7	2 p. m	1,760		5,000	Heavy hail	Crops damaged and poultry killed	Do.
Grundy County, Iowa	7	P. m			100,000	Hail	Total loss of crops to many farmers	Do.
Airlie, Minn	11	6 p. m	4-5 mi			Small tornado	Four buildings wrecked	Official, U. S. Weather Bureau; Press and Dakotan (Yankton, S. Dak.).
Lamar, Mo	11-12					Wind and rain	Damage principally to crops	Official, U. S. Weather Bureau.
Furnas County, Nebr	12	7 p. m	6 mi			Heavy hail	Loss of crops partial to total; buildings more or less damaged.	Do.
Decatur County, Kans	12	11 p. m	4-6 mi			Hail	Very destructive storm; wheat and other crops heaviest sufferers; some property damage.	Do.
Smith County, Kans	12	P. m	1,320			do	Growing crops badly injured	Do.
Ellsworth County, Kans	13	5 p. m	10-15 mi			do	Damage comparatively small	Do.
Ford County, Kans	13	P. m				Tornado	Farm buildings damaged	Do.
Dodge City, Kans. (5 mi. sw. of)	13	P. m				do	Minor damage reported	Do.
McPherson County, Kans	13	7 p. m			100,000	do	Barns, houses, windmills, poles, and wires leveled; much stacked wheat blown away.	Do.
Butler County, Kans	13	8:15-8:45 p. m.	80-880	1	2,000,000	do	20 persons injured rather seriously, 80 slightly. Augusta suffered most; 76 dwellings, 21 business houses, and 1 church destroyed; many others damaged; 300 oil rigs wrecked in near-by territory.	Do.
Devon, Kans. (Bourbon County)	13	9:30 p. m	66			do	Destruction confined to barns, trees, and outbuildings.	Do.
Bourbon County, Kans., from Fort Scott north.	13	P. m				Severe wind	Damage chiefly to barns, garages, telephone and telegraph poles.	Do.
Chase County, Nebr	13	9:30 p. m	2-mi			Hail	Loss of crop estimated at from 25 to 75 per cent.	Do.
Jeffersonville, N. Y	13		880			Moderate hail	Corn stripped; potatoes beaten to ground.	Do.
Claiborne County, Tenn	14	P. m	1-3 mi			Hail	Corn, tobacco, and tomatoes damaged. Path 25 miles long.	Do.

[1] Yards when not otherwise specified; "mi." signifies miles

SEVERE LOCAL HAIL AND WIND STORMS, JULY, 1924—Continued

Place	Date	Time	Width of path	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Jefferson and Cocke Counties, Tenn. (parts of).	14	P. m.			50,000	Hail	Total loss of crops in parts of path.	Official, U. S. Weather Bureau.
Oconto County, Wis.	15	5 p. m.	2 mi.			Heavy hail	Crops considerably damaged.	Do.
Purdum, Nebr. (2 mi. e. of)	16	6 p. m.				Small tornado	One residence and several farm buildings wrecked; some livestock killed.	Do.
Nance, Merrick, and Polk Counties, Nebr.	16	8-9:30 p. m.	4-6 mi.			Hail and wind	Much harm to gardens and small grains; windmills blown down, trees uprooted, buildings damaged.	Do.
Port Huron, Mich., and vicinity.	16	P. m.				Electrical and wind.	Several barns struck and burned; wire lines and trees blown down.	Do.
Sedalia to St. Louis, Mo.	16-17	11 p. m.-3 a. m.			115,000	Electrical and wind.	Extensive damage to trees, wire systems, buildings, and crops.	Do.
Simpson (near), Colo.	17	4 p. m.	1,760		2,000	Heavy hail and electrical.	Some stock killed by lightning; small property and crop damages.	Do.
Bridgeton and Millville, N. J. (vicinity of).	17					Hail	General damage reported.	Do.
Eastport, Me.	17	11 a. m., 6:10 p. m.				Electrical	Slight damage in city, considerable in neighboring towns.	Do.
Fitchburg (near), Mass.	17	Noon	17-1,400	2	500,000-1,000,000	Tornado	Heavy property damage. A detailed account will probably appear in a later REVIEW.	Do.
Broadus, Mont. (10 mi. w. of)	18		200			do	Ranch house and barn damaged.	Do.
Holyoke, Colo.	19	6:30 p. m.	5-6 mi.			Heavy hail and wind.	Buildings, trees, and crops damaged; poultry killed.	Do.
Rattlesnake Buttes (near), Colo.	20	P. m.				Heavy hail	75 lambs and numerous rabbits and birds killed.	Do.
Fortsonia, Ga.	20	7 p. m.	3 mi.		175,000	Hail	Crops completely destroyed; many buildings damaged. Path 6 miles long.	Do.
Lake Erie to Hudson Valley, N. Y.	20-21					Thunderstorms	Heavy fruit, crop, and property destruction.	Do.
Dane, Iowa, Jefferson and Rock Counties, Wis.	20-21	P. m.			40,000	do	Loss mainly of farm buildings and crops.	Do.
Norfolk, Nebr.	21	12:20 a. m.	75			Tornado	Several residences damaged, trees uprooted, light and telephone poles down.	Do.
Independence County, Iowa	21	1 a. m.	1,320		75,000	Hail	Severe damage to crops and some roofs.	Do.
Dewar, Iowa	21	P. m.	3 mi.		125,000	Hail, wind and rain.	Extensive crop damage; livestock injured.	Do.
Hamilton County, Iowa (n. half of).	21	5 p. m.			10,000	Hail	Destruction of property and crops reported.	Do.
Eastern Grant and northwestern Lafayette Counties, Wis.	22	3:30-5:30p.m.	2-10 mi.		100,000	Strong wind	Farm buildings and crops severely damaged; much livestock injured.	Do.
Charles City, Iowa, and vicinity.	22	P. m.				Wind and hail	Wires and poles down; crops badly damaged.	Do.
Summerton, S. C.	23	P. m.		1		Thunderstorm	Damage not reported.	Morning Daily State (Columbia, S. C.).
Hamburg (near), Pa.	23	6:30-6:32p.m.	880			Tornadic wind	One barn, several outbuildings and 3 acres of orchard destroyed.	Official, U. S. Weather Bureau.
Iowa Falls, Iowa	23	10 p. m.	2 mi.		50,000	Hail	Corn loss, 100 per cent; oats, 50 per cent.	Do.
Palma, N. Mex.	24	2:30 p. m.	880		2,000	Heavy hail	Storm covered about 7 miles, causing great damage.	Do.
Tajique (near) N. Mex.	24				60,000	Heavy hail and rain.	Greatest damage by flooding of fields and pastures.	Do.
Jackson Ferry Landing, New Orleans, La.	24	5 p. m.		5	29,225	Thundersquall	River packet capsized, damaging boat and cargo. Some roofs near by damaged.	Do.
Martinsburg, Mo.	24	11:40 p. m.	3,520			Wind	Barns blown over; 2 cows killed; wire systems and trees damaged.	Do.
Harlem, Mont. (7 mi. w. of)	25	2:40 p. m.	100			Tornado	Farm home and many farm buildings demolished; large cottonwood trees twisted off.	Do.
Clint, Tex.	25		880			Heavy hail	Cotton stripped; other crops injured.	Do.
Jacksonville, Fla.	25				200,000	Electrical	Damage chiefly to Armour factory.	Do.
Palo Alto, Kossuth, and Humboldt Counties, Iowa.	27	2:30-4:30 p.m.				Hail	Considerable crop and property damage throughout area covered. Damage in Palo Alto alone estimated at $150,0000.	Do.
Dubuque County, Iowa	27	4 p. m.				do	Considerable loss of crops.	Do.
Grundy Center, Iowa	27	5 p. m.	4 mi.		50,000	do	Corn crop ruined; other minor damage.	Do.
Plymouth County, Iowa	27	6 p. m.	4 mi.		300,000	do	Crops heavily damaged; poultry killed and stock injured.	Do.
Munising, Mich.	27					Hail and wind	Hailstones large, but no great damage.	Do.
Jamestown, N. Y.	28	4 p. m.				Hail, rain, wind and electrical.	Corn stripped, vineyards damaged, highways washed out, wire communication interrupted. Three barns burned.	Do.
Genesee and Wayne Counties, N. Y.	29					Winds	Thousands of dollars damage to young celery plants, onions, and lettuce.	Do.
McDonough County, Ill.	29	P. m.	1,760		200,000	Wind and rain	5 barns and a house unroofed, corn laid flat; thousands of acres of bottom lands at Macomb damaged by flooding.	Do.
Smithfield, R. I.	30					Wind	Unfinished roof collapsed, injuring a number of workmen.	Do.
Acton (near), Ind.	30					Tornado	Slight damage.	Do.
Mountain Park, N. Mex.	30	Noon-1 p. m.	1,760		15,000	Heavy hail	Homes and orchards badly damaged.	Do.
Manistee, Mich.	30	6:30 p. m.			10,000	Hail, wind, and rain.	Character of damage not reported.	Do.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

Small-craft warnings were ordered for the Atlantic coast from New York City northward on the 25th. On the 29th indications were disseminated through radio bulletins for strong east winds and possibly moderate gales, at times, off the North Atlantic coast in connection with a disturbance that had originated off the South Atlantic coast and had moved to a position off Cape Hatteras by that morning. This disturbance advanced east-northeastward through a region from which vessel reports are not yet available. Therefore nothing can be said definitely as to its subsequent development nor of the winds attending it. No other warnings were issued during the month.

July was characterized by a preponderance of Alberta HIGHS, which are usually active and seldom stagnate. The one that appeared over the Northwest on the evening of June 29 advanced to the northern Plains States and western Ontario by the morning of the 1st. It moved very slowly eastward to the Lake region, where it decreased in intensity and remained nearly stationary over that region until the 7th. Its influence was felt in the United States from June 28 to July 7, a period of about 10 days.—*R. H. Weightman.*

CHICAGO FORECAST DISTRICT

Storm warnings.—On the Great Lakes, July, 1924, was a period of freedom from severe storms. Although a few winds of verifying velocity occurred at various times, these in virtually all cases were of short duration and mainly in connection with thunderstorms. The only storm warning issued was that on the morning of the 9th, when a disturbance of increasing energy was centered just north of Lake Superior. Southwest warnings were displayed on Lake Huron and northwest warnings on eastern Lake Superior, while small-craft warnings were advised for Lakes Erie and Michigan, and although the only verifying velocity occurred at Buffalo, N. Y., nevertheless fresh to moderately strong winds occurred almost generally on the Lakes. On the 16th, 22d, and 24th small-craft warnings were advised for portions of the Lakes in expectation of thundersquall conditions.

Frost warnings.—On the morning of the 1st, when a large, cool, high-pressure area covered the northern Plains region and the Upper Mississippi Valley, light frost was forecast for the Wisconsin cranberry marshes. On the following morning light frost occurred at Shell Lake, and temperatures low enough for frost at the other two reporting stations. Again on the 13th and 17th advices were issued to the effect that light frost might occur in the marshes. The lowest temperature reported on the 14th was 37°, and on the 18th, 29°, but in neither case was frost observed.

Long-range forecasts for the benefit of the Forest Service in western Montana, and of the fruit interests in Door County, Wis., and in southwestern Michigan, were continued. A new feature was the inauguration of flying forecasts for the transcontinental air mail service.—*C. A. Donnel.*

NEW ORLEANS FORECAST DISTRICT

No storm occurred on the West Gulf coast during July, and no storm warnings were issued. There was no severe weather in any part of the district.

There were considerable areas where very little rain occurred during the month. Precipitation which did occur was, as a rule, forecast.—*I. M. Cline.*

DENVER FORECAST DISTRICT

During the first seven days of the month, low pressures prevailed in most of the Rocky Mountain region, with high, or relatively high, pressures to the eastward, attended by occasional showers and thunderstorms over nearly the whole district. Heavy rains in southeastern New Mexico on the 9th and 10th preceded the rapid southward movement of a High along the eastern Rocky Mountain slope. At Roswell the 24-hour rainfall, reported on the morning of the 10th, was 2.12 inches, and at Fort Stanton, 2 inches.

During the last two decades of the month, a succession of LOWS moved southeastward from western Canada. The individual LOWS were followed, usually, by HIGHS of weak or only moderate intensity. Appreciable amounts of precipitation were infrequent, especially in the northern and extreme western portions of the district.

Except in southern New Mexico and, apparently in portions of eastern Arizona, the rainfall was generally below normal, with a decided deficiency in Colorado, western Arizona and Utah.

No special warnings were issued during the month.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT

The month was marked by a continuation of dry weather generally, but with considerable cloudiness and fog along the coast. The only rains of consequence during the month occurred in Washington and Oregon during the period beginning on the 13th and ending on the 20th. Local rains also occurred in Idaho during the last two days of this period and also on widely separated days. It is to be observed that the period of unsettled weather and local rains in Washington and Oregon coincided with a period of abnormally low barometric pressure over the Aleutian Islands and Alaska, and that the period ended when the barometer rose over the Gulf of Alaska.

As this depression was the outstanding feature of the weather charts of the month, it is important for purposes of record that the general pressure distribution in connection therewith be described. The weather charts and daily pressure graphs showed a well-defined depression over the Aleutian Islands from the 11th to 21st, inclusive. The pressure graphs, considered alone, indicate that there were two disturbances in this region, whereas the weather charts indicate but one. This disturbance moved irregularly, first advancing eastward beyond Dutch Harbor after the 18th, then recurving counter clockwise, completing a movement of 360°, then passing northeastward and finally disappearing north of the Yukon Valley.

The important pressure phenomenon subsequently noticed in connection with this turning movement was the general and rapid increase in pressure over the Gulf of Alaska as the disturbance moved into the Yukon Valley, terminating the period of unsettled, showery weather in Washington and Oregon.

The fire-weather hazard continued high throughout the month in California and during the first half of the month and on the 23d to the 27th over the greater part of Washington and Oregon and in Idaho. Daily advices were issued concerning the prevailing and expected fire-

weather hazard. The situation with respect to forest fires in California was critical at all times, and the number of fires was greatly beyond that of an average year. Many of the forest reserves were closed to campers in order to decrease the number of fires caused by neglect and carelessness.

It was not necessary during July to issue warnings of any kind other than for fire weather.—*E. H. Bowie.*

RIVERS AND FLOODS

By ROBIN E. SPENCER, Principal Observer

Floods in the Atlantic drainage area during July, 1924, were confined to the first half of the month and to the rivers of the Carolinas, rainfall in those States having been heavy during, and in some cases following, the first week. Warnings, which were in the main timely and well verified, resulted in a saving of movable property valued at upwards of $20,000. Losses were estimated at about $80,000, including $20,000 in crops.

In the Mississippi Valley floods of some importance occurred in the Illinois, Grand, and Osage Rivers. Considerable losses in crops occurred along the Illinois, at and below Peru, where the river continued above flood stage from late June until July 20; while the result of overflow along the Grand and Osage was less costly in direct damage than in the effect of finally preventing for the present season the planting of a considerable extent of bottom lands which had hitherto remained unplantable on account of wet weather.

Reports received too late for inclusion in the June number of this REVIEW place unavoidable losses in prospective crops for the Des Moines and Mississippi flood which occurred between June 28 and July 1 from Keokuk, Iowa, to Louisiana, Mo., and at Cape Girardeau, Mo., on July 4, at $100,000, the total saving through warnings being about $11,000.

The record of run-off of the Colorado River for the month of July, 1924, clearly indicates the deficiency in the water supply of the present season over the Far West. The total discharge at Yuma, Ariz., for July was 1,134,900 acre-feet, as compared with 2,633,000 acre-feet in July, 1923, and a normal discharge of 2,292,880 acre-feet. There is no prospect of increased flow for some months unless a series of good rains occurs over the upper drainage area.

River, and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC DRAINAGE					
Roanoke:	*Feet*			*Feet*	
Weldon, N. C	30	11	11	33.5	11
Tar:					
Tarboro, N. C	18	5	7	19.5	6
Greenville, N. C	14	6	10	15.8	7–8
Fishing Creek:					
Enfield, N. C	15	2	4	16.8	2
Neuse:					
Neuse, N. C	15	2	3	16.6	3
Smithfield, N. C	14	1	5	17.4	3
Cape Fear:					
Elizabethtown, N. C	22	3	5	24.8	3
Waccamaw:					
Conway, S. C	7	7	27	9.0	15–17
Peedee:					
Mars Bluff, S. C	17	11	15	18.4	13
Black:	*Feet*			*Feet*	
Kingstree, S. C	12	3	13	14.6	6
Santee:					
Rimini, S. C	12	2	21	16.6	13
Ferguson, S. C	12	3	26	13.8	13–15
Wateree:					
Camden, S. C	24	9	10	24.5	9
Broad:					
Blairs, S. C	15	7	9	16.9	7
Saluda:					
Chappells, S. C	14	8	10	16.8	9
GREAT LAKES DRAINAGE					
St. Joseph:					
Montpelier, Ohio	10	([1])	1	11.4	June 30
MISSISSIPPI DRAINAGE					
Mississippi:					
Quincy, Ill	14	([1])	1	15.2	June 30
Hannibal, Mo	13	([1])	2	15.2	June 30
Louisiana, Mo	12	([1])	3	14.0	1
Alton, Ill	21	([1])	5	22.8	3
Cape Girardeau, Mo	30	4	4	30.1	4
Illinois:					
Morris, Ill	13	([1])	2	14.5	June 29
Peru, Ill	14	([1])	18	18.4	June 30–July 1
Henry, Ill	7	([1])	29	12.7	2–3
Peoria, Ill	16	([1])	19	19.7	3–4
Havana, Ill	14	([1])	20	18.0	3
		23	24	14.1	24
Beardstown, Ill	12	([1])	([2])	19.1	4–5
Pearl, Ill	12	([1])	18	16.2	5
Missouri:					
Hermann, Mo	21	([1])	1	21.5	June 30
St. Charles, Mo	25	June 29	4	27.1	June 30–July 1
Grand:					
Gallatin, Mo	20	18	19	26.2	18
Chillicothe, Mo	18	([1])	2	28.1	June 29
		18	20	19.6	19
Brunswick, Mo	10	([1])	5	14.3	June 30–July 1
		20	23	10.7	21
Osage:					
Osceola, Mo	20	14	16	21.8	14
Warsaw, Mo	22	15	17	25.1	16
WEST GULF DRAINAGE					
Colorado:					
Parker, Ariz	7	([1])	10	9.4	June 22

[1] Continued from last month. [2] Continued at end of month.

MEAN LAKE LEVELS DURING JULY, 1924

By UNITED STATES LAKE SURVEY

[Detroit, Mich., August 7, 1924]

The following data are reported in the "Notice to Mariners" of the above date:

Data	Lakes[1]			
	Superior	Michigan and Huron	Erie	Ontario
	Feet	*Feet*	*Feet*	*Feet*
Mean level during July, 1924				
Above mean sea level at New York	601.39	579.52	572.45	246.21
Above or below—				
Mean stage of June, 1924	+0.11	+0.14	+0.09	−0.06
Mean stage of July, 1923	−0.48	−0.36	+0.46	+0.41
Average stage for July last 10 years	−1.17	−1.39	−0.37	−0.45
Highest recorded July stage	−2.43	−4.06	−1.96	−2.51
Lowest recorded July stage	−0.09	−0.36	+0.99	+1.62
Average relation of the July level to—				
June level		+0.1	([2])	([2])
August level		+0.1	+0.2	+0.3

[1] Lake St. Clair's level: In July, 1924, 574.94 feet. [2] Practically no difference.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS—JULY, 1924

By J. B. KINCER

In general.—The cessation of rainfall in the interior valleys during the first half of July brought more favorable weather for haying and harvesting and the cultivation of row crops, but there was further interruption to field work by frequent rains during the week ending July 22. The latter part of the month had generally light rainfall and much sunshine, and outdoor operations made good advance during that period. There was sufficient soil moisture, as a rule, in Central and Northern States, east of the Rocky Mountains, though at the close of the month it was getting rather dry in limited areas of the Ohio Valley and northern Great Plains, while rain was badly needed in the middle Atlantic coast section.

The first part of the month was too wet in the Southeastern States, but conditions improved materially during the latter half when there was less rainfall, and favorable temperatures promoted good growth. There was generally a marked lack of moisture in the central and west Gulf sections, but sufficient rainfall to materially improve conditions in much of the far Southwest, particularly in New Mexico and Arizona. West of the Rocky Mountains severe drought continued throughout the month, and while irrigated crops did fairly well, all dry-land crops suffered, and there was considerable complaint of insufficient water for proper irrigation. Drying winds in the North Pacific States increased the forest-fire hazard.

The first week of the month was much too cool for rapid growth of crops in nearly all sections east of the Rocky Mountains, the temperatures being especially low in the interior valley States and southern Plains area. Thereafter temperatures were more favorable in the South and were somewhat higher in central and northern districts, although in the latter section the nights continued too cool for best advance of warm-weather crops.

Winter wheat.—The weather was favorable in most sections for the harvesting of winter wheat, except for some delay by showers in the upper Mississippi Valley and north-central Great Plains, and threshing was making good progress at the close of the month. Unusually favorable weather for filling and ripening wheat prevailed in the Central and Northern States, and yields were better in many places than the previous condition of the crop had indicated, except in the droughty sections of the far Northwest.

Spring wheat and oats.—Spring wheat and oats made splendid advance with the generally cool weather and ample soil moisture, and at the close of the month the former had practically all headed out in the northern border States, with general condition reported as satisfactory.

Corn.—The first 10 days of July were drier and more favorable for cultivating corn in the interior States, but growth continued slow because of cool nights. The middle and latter parts of the month brought considerably better corn weather in most sections, as temperatures were somewhat higher, though it remained too cool for good growth and rain was needed in some sections of the Great Plains and locally in the Ohio Valley. There was some improvement in this crop during the month, though its general condition remained poor in much of the principal producing area and the crop was very late, thus making the frost hazard unusually great.

Cotton.—The early part of the month was too cool for best growth of cotton, and the first half was too wet in eastern cotton districts, while soil moisture was further depleted generally in the western portion of the belt. The latter half was drier, moderately warm, and much more favorable in the eastern cotton States, but drought continued from the lower Mississippi Valley westward, where rainfall was badly needed in most sections. At the close of the month the crop showed substantial improvement in the east, and early cotton was standing the drought well in Texas, though the late-planted was becoming stunted, with considerable complaint of shedding. Poor to only fair progress was the rule also, because of deficient moisture, in parts of Alabama and Tennessee, Louisiana, and the southern portions of Arkansas and Oklahoma.

Potatoes and hardy truck crops.—Potatoes and hardy truck crops did well in Central and Northern States east of the Rocky Mountains, but it was too dry for all minor crops in the Southwest, and more moisture was badly needed in parts of the Atlantic coast area.

Livestock.—The range continued mostly good in the Great Plains States and the far Southwest, but dry from the Rocky Mountains westward. Livestock remained in good to excellent condition, however, quite generally over the principal grazing areas of the Western States.

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CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation, by sections, July, 1924

Section	Temperature		Monthly extremes						Precipitation		Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	79.8	−0.2	2 stations	103	[2]22	Valley Head	49	1	3.45	−2.13	Alaga	10.59	Calera	0.57
Arizona	79.7	+0.2	3 stations	115	31	2 stations	34	[2]12	1.82	−0.71	Blue	6.77	3 stations	0.00
Arkansas	79.0	−0.9	Pine Bluff	110	[2]23	Corning	40	1	2.35	−1.57	Eureka Springs	9.46	2 stations	0.00
California	71.3	−1.9	Greenland Ranch	124	1	Helm Creek	26	30	0.01	−0.07	Seven Oaks	1.34	203 stations	0.00
Colorado	65.7	−0.3	2 stations	104	[2]8	Corona	18	29	1.26	−1.09	Yuma	4.54	3 stations	T.
Florida	81.4	+0.3	New Smyrna	101	25	Cottage Hill	59	5	9.76	+2.96	Bartow	16.91	Sand Key	1.12
Georgia	79.9	−0.2	2 stations	104	23	Blue Ridge	49	3	5.62	−0.15	Valdosta	12.99	Tallapoosa	1.11
Hawaii	73.6	−0.2	Kipahulu	94	14	Kula Sanitarium	50	8	6.15	−0.06	Puu Kukui (upper)	29.00	2 stations	0.00
Idaho	68.0	+0.2	Weiser	115	2	Stanley	17	30	0.50	−0.21	Pocatello	1.67	4 stations	0.00
Illinois	71.9	−4.0	Mount Carmel	101	[2]21	2 stations	41	3	3.33	−0.11	La Harpe	8.51	Paris	0.65
Indiana	71.8	−3.5	Collegeville	99	29	do	42	[2]2	1.92	−1.53	Logansport	5.60	Huntington	0.44
Iowa	70.2	−3.6	Clinton	99	21	do	41	[2]1	3.67	−0.17	Olin	8.90	Milford	0.57
Kansas	75.6	−2.6	2 stations	109	[2]16	5 stations	42	[2]2	3.69	+0.27	Fort Scott	10.36	Goodland	0.30
Kentucky	73.4	−3.5	Bowling Green	99	22	Berea	45	1	3.67	−0.50	Taylorsville	6.38	Leitchfield	0.89
Louisiana	82.2	+0.6	Dodson	109	24	Minden	50	4	1.53	−4.89	Delta Farms	4.63	2 stations	0.00
Maryland-Delaware	73.0	−2.2	Frederick, Md	100	30	Freeland, Md	42	19	2.48	−1.86	Oakland, Md	5.95	Coleman, Md	0.29
Michigan	65.5	−3.0	Flint	100	23	Ewen	29	17	3.48	+0.53	East Tawas	6.80	Detroit	0.78
Minnesota	66.4	−2.7	4 stations	95	[2]22	3 stations	34	[2]2	2.77	−0.78	Cloquet	6.98	Winnebago	0.75
Mississippi	81.2	+0.3	Monticello	108	24	do	50	[2]2	1.71	−3.46	Merrill	6.20	Natchez	T.
Missouri	73.3	−4.1	Caruthersville	103	24	Hollister	40	[2]3	5.39	+1.34	New Madrid	14.52	Kirksville	2.14
Montana	66.1	−0.1	3 stations	106	2	2 stations	27	[2]7	1.12	−0.31	Hebgen Dam	3.22	Forsyth	0.15
Nebraska	71.7	−2.6	Alma	105	16	Gordon	37	25	3.76	+0.33	Cairo	8.66	Scottsbluff	0.49
Nevada	73.0	+0.3	Pahrump	117	1	Millett	31	18	0.16	−0.23	Arthur	0.91	12 stations	0.00
New England	68.7	−0.2	New Bedford, Mass	99	23	Van Buren, Me	35	27	2.19	−1.58	Garfield, Vt	7.37	Block Island, R. I.	0.32
New Jersey	71.6	−1.6	Little Falls	98	30	2 stations	41	[2]19	2.59	−2.05	Somerville	5.08	Belle Plain	0.84
New Mexico	71.7	−0.6	Jal	108	12	Lee's Ranch	30	22	2.92	+0.28	Pinos Altos (near)	11.02	Glenrio	0.12
New York	68.0	−2.0	Port Jervis	98	29	Gabriels	31	26	3.38	−0.44	Dannemora	8.98	Medford	0.34
North Carolina	74.5	−1.6	Kinston	100	25	Mount Mitchell	40	1	6.42	+0.17	Rock House	14.83	Murphy	1.62
North Dakota	65.5	−2.0	Beach	99	28	Hansboro	32	[2]13	1.95	−0.66	Stanton	3.97	McHenry	0.57
Ohio	70.3	−3.3	Middleport	98	24	2 stations	41	[2]2	2.84	−1.10	Clarington	6.15	New Bremen	0.71
Oklahoma	79.6	−1.4	Beaver	111	20	Goodwell	45	5	2.89	+0.02	Broken Arrow	7.57	2 stations	0.00
Oregon	65.6	+0.1	McMinnville	110	24	Fremont	23	[2]15	0.13	−0.40	Cove	1.01	28 stations	0.00
Pennsylvania	69.7	−2.3	3 stations	97	30	2 stations	34	19	3.42	−0.79	Huntingdon	7.12	Pottstown	0.71
Porto Rico	78.7	−0.1	2 stations	98	[2]1	do	58	[2]1	6.16	−0.49	Rio Grande	13.06	Potala	2.00
South Carolina	78.6	−1.1	Garnett	103	23	Walhalla	56	26	6.93	+0.97	Georgetown	17.03	Winnsboro	2.76
South Dakota	69.2	−2.4	Pukwana	104	15	2 stations	35	[2]3	1.68	−1.16	Menno	5.79	White Lake	0.34
Tennessee	75.7	−1.7	Brownsville	103	22	Crossville	42	2	3.81	−0.77	Copperhill	7.99	Covington	0.28
Texas	82.6	−0.3	Encinal	109	24	Miami	45	5	0.94	−1.79	Muleshoe	8.13	18 stations	0.00
Utah	71.5	+0.4	St. George	110	6	Woodruff	29	21	0.89	−0.01	Lowder ranger station	4.51	2 stations	T.
Virginia	72.7	−2.6	Danville	100	22	Burkes Garden	38	18	3.61	−0.98	Diamond Springs	6.25	Manassas	0.96
Washington	66.7	+0.5	Trinidad	113	1	Paradise Inn	20	7	0.50	−0.17	Cedar Lake	2.18	4 stations	0.00
West Virginia	70.0	−2.8	Martinsburg	99	30	Cheat Bridge	36	18	4.49	−0.17	Pickens	7.63	Harpers Ferry	1.65
Wisconsin	66.2	−3.2	Prairie du Chien	95	10	Long Lake	29	2	3.58	−0.13	Koepenick	6.10	Merrill	1.67
Wyoming	64.8	−0.8	Basin	101	15	South Pass City	21	21	0.89	−0.36	Buffalo	5.02	2 stations	T.

[1] For description of tables and charts, see REVIEW.

[2] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, July, 1924*

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature: Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.		°F	°F.	°F.	°F.	%	In.	In.		Miles								0–10	In.	In.
New England							**68.9**	**0.0**										**75**	**1.79**	**−1.8**										**4.5**		
Eastport	76	67	85	29.81	29.89	−.04	61.2	+0.8	84	12	71	46	6	52	28	56	53	80	3.29	−0.1	7	5,849	s.	24	sw.	15	7	14	10	6.0	0.0	0.0
Greenville, Me	1,070	6	----	28.78	29.92	-----	65.2	-----	87	12	76	42	1	54	34	----	----	----	3.07	-----	13	-----	nw.	----	----	----	12	12	7	----	0.0	0.0
Portland, Me	103	82	117	29.83	29.95	.00	68.5	+0.4	90	30	78	52	26	59	32	61	56	68	2.42	−0.8	8	6,158	s.	28	w.	18	15	10	6	4.2	0.0	0.0
Concord	288	70	79	29.64	29.94	−.02	69.8	+1.3	92	29	83	45	15	57	37	----	----	----	1.74	−2.0	7	3,679	w.	28	w.	17	18	10	3	3.1	0.0	0.0
Burlington	404	11	48	29.50	29.92	−.02	68.0	−2.3	89	29	78	46	15	58	31	----	----	----	1.99	−1.8	12	6,863	s.	40	nw.	25	11	9	11	5.8	0.0	0.0
Northfield	876	12	60	29.02	29.95	+.01	65.0	−0.9	88	29	78	40	15	52	36	62	60	82	3.27	−0.4	14	4,639	s.	30	sw.	25	9	11	11	5.6	0.0	0.0
Boston	125	115	188	29.82	29.95	−.01	73.8	+2.1	95	30	83	58	4	65	27	64	58	63	2.04	−1.3	7	6,736	sw.	34	w.	17	9	18	4	4.5	0.0	0.0
Nantucket	12	14	90	29.96	29.97	−.01	67.4	−0.4	83	24	74	56	6	61	20	63	62	87	1.78	−0.9	9	10,361	sw.	42	sw.	17	11	11	9	4.7	0.0	0.0
Block Island	26	11	46	29.95	29.98	+.01	67.6	−0.8	84	24	74	56	6	62	21	63	61	85	0.32	−3.0	8	9,554	sw.	34	w.	17	16	6	9	4.3	0.0	0.0
Providence	160	215	251	29.80	29.97	.00	72.2	−1.2	95	30	82	55	4	62	31	64	58	64	1.12	−2.4	4	5,777	sw.	58	nw.	30	15	12	4	3.8	0.0	0.0
Hartford	159	122	140	29.80	29.97	.00	72.6	+1.0	93	30	83	55	15	62	34	----	----	----	0.54	−3.6	4	-----	s.	----	----	----	17	10	4	3.5	0.0	0.0
New Haven	106	74	153	29.86	29.97	.00	71.7	−0.1	94	30	80	55	18	63	26	64	59	68	1.17	−3.6	6	6,001	sw.	27	sw.	17	17	3	11	4.4	0.0	0.0
Middle Atlantic States							**73.1**	**−1.6**										**70**	**2.91**	**−1.5**										**5.1**		
Albany	97	102	115	29.86	29.96	.00	72.2	−0.4	91	29	82	55	20	62	29	64	60	69	2.25	−1.6	11	5,012	s.	30	s.	22	15	9	7	4.1	0.0	0.0
Binghamton	871	10	84	29.05	29.96	−.01	68.8	−1.2	90	29	80	46	20	58	34	----	----	----	3.91	+0.4	15	3,561	w.	20	w.	17	13	10	8	4.8	0.0	0.0
New York	314	414	454	29.66	29.99	+.01	72.6	−1.2	91	30	80	58	18	65	23	64	59	67	1.30	−3.2	8	10,452	s.	57	nw.	10	10	11	10	5.1	0.0	0.0
Harrisburg	374	94	104	29.61	30.00	+.02	73.4	−1.4	93	30	82	56	19	64	29	65	61	68	4.52	+0.6	10	3,934	w.	18	s.	7	11	9	11	5.1	0.0	0.0
Philadelphia	114	123	190	29.88	30.00	+.02	75.6	−0.6	94	30	84	60	18	67	23	66	61	65	3.18	−1.2	6	5,614	w.	29	n.	17	13	6	12	5.1	0.0	0.0
Reading	325	81	98	29.65	29.99	-----	73.3	-----	93	30	83	55	19	64	29	67	63	73	1.76	−2.5	8	3,993	nw.	22	nw.	17	15	11	5	4.2	0.0	0.0
Scranton	805	111	119	29.16	30.00	+.02	69.8	−1.9	91	29	81	49	15	59	33	66	63	78	3.65	−0.2	9	4,606	sw.	28	w.	17	9	14	8	5.2	0.0	0.0
Atlantic City	52	37	172	29.94	29.99	+.01	72.2	+0.1	92	30	79	56	18	66	23	67	64	78	1.45	−2.3	8	10,295	s.	48	nw.	17	16	10	5	3.6	0.0	0.0
Cape May	17	13	49	30.02	30.04	+.06	73.4	0.0	93	30	81	59	3	65	25	67	65	81	1.31	−2.5	6	4,478	s.	17	w.	10	16	10	5	3.9	0.0	0.0
Sandy Hook	22	10	55	29.97	29.99	-----	72.6	-----	91	30	80	60	19	66	24	65	62	76	1.22	-----	8	8,628	s.	56	nw.	17	14	8	9	4.4	0.0	0.0
Trenton	190	159	183	29.80	30.00	-----	73.2	-----	94	30	83	55	19	64	28	65	62	69	4.21	−0.6	5	6,436	sw.	36	nw.	17	12	9	10	5.0	0.0	0.0
Baltimore	123	100	113	29.87	29.99	+.01	76.1	−1.1	95	30	84	60	19	68	23	68	63	66	1.99	−2.8	5	3,826	s.	17	s.	7	13	10	8	4.8	0.0	0.0
Washington	112	62	85	29.89	30.00	.00	75.0	−1.8	95	30	84	58	19	66	31	67	64	70	2.76	−1.9	9	3,694	nw.	24	nw.	17	13	11	7	4.4	0.0	0.0
Cape Henry	18	8	54	29.98	30.01	-----	75.4	-----	96	30	82	63	4	69	28	71	69	83	3.66	−2.2	9	7,450	se.	42	nw.	25	8	14	9	5.6	0.0	0.0
Lynchburg	681	153	188	29.28	30.01	.00	74.0	−3.5	93	30	84	55	18	64	33	67	65	76	3.74	−0.3	8	3,685	n.	37	nw.	17	9	15	7	4.8	0.0	0.0
Norfolk	91	170	205	29.93	30.02	+.02	76.6	−2.1	92	24	84	64	4	70	22	70	67	78	4.45	−1.4	11	7,189	s.	52	nw.	10	8	13	10	5.8	0.0	0.0
Richmond	144	11	52	29.87	30.02	+.01	75.1	−3.4	94	30	84	60	18	66	28	69	66	76	2.33	−2.1	10	4,217	s.	27	nw.	25	14	10	7	4.5	0.0	0.0
Wytheville	2,304	49	55	27.72	30.03	+.02	68.4	−4.2	86	23	78	50	18	59	28	63	61	82	3.13	−1.3	16	2,982	w.	17	w.	31	7	15	9	5.7	0.0	0.0
South Atlantic States							**78.1**	**−1.0**										**81**	**7.86**	**+1.8**										**5.6**		
Asheville	2,255	70	84	27.75	30.03	+.01	71.0	−0.7	87	22	80	56	26	62	26	65	63	84	5.70	+1.0	17	4,071	se.	38	n.	17	4	20	7	5.8	0.0	0.0
Charlotte	779	55	62	29.20	30.02	.00	77.0	−1.4	96	22	86	60	1	68	27	69	66	75	3.01	−2.5	12	2,598	n.	23	nw.	10	9	9	13	5.9	0.0	0.0
Hatteras	11	11	50	30.00	30.01	.00	76.8	−1.4	88	25	82	67	4	72	17	73	71	83	12.10	+6.0	18	8,851	sw.	43	nw.	25	9	11	11	5.5	0.0	0.0
Manteo	12	5	42				76.8	-----	94	25	---	58	19	---	26	----	----	----	4.54	-----	6	-----	s.	----	----	----	14	4	13	----	0.0	0.0
Raleigh	376	103	110	29.63	30.01	−.01	76.2	−2.6	93	23	85	61	3	68	27	69	67	79	5.59	−0.5	15	4,437	e.	37	n.	25	9	13	9	5.5	0.0	0.0
Wilmington	78	81	91	29.94	30.03	+.02	77.9	−1.2	95	23	85	62	29	70	26	73	71	82	13.82	+6.8	14	4,565	sw.	24	s.	15	9	15	7	5.2	0.0	0.0
Charleston	48	11	92	29.97	30.02	−.01	81.2	−0.2	95	31	88	68	3	75	20	76	75	86	6.59	−0.7	16	6,474	sw.	35	nw.	23	7	12	12	5.8	0.0	0.0
Columbia, S. C	351	41	57	29.65	30.02	.00	79.6	−1.3	98	25	88	65	3	71	26	73	71	84	6.00	−0.1	19	3,668	ne.	19	nw.	25	10	12	9	5.5	0.0	0.0
Due West	711	10	55	29.28	30.04	-----	77.7	-----	96	23	87	61	4	68	29	----	----	----	5.29	-----	10	4,561	sw.	27	nw.	31	8	14	9	5.7	0.0	0.0
Greenville, S. C	1,039	113	122	28.94	30.01	-----	76.5	−0.4	93	22	85	60	4	68	25	70	67	78	5.95	-----	16	4,598	e.	39	n.	17	10	12	9	5.2	0.0	0.0
Augusta	180	62	77	29.82	30.00	−.02	81.0	−0.3	100	23	90	65	3	72	28	73	71	77	5.57	+0.3	12	3,199	s.	33	n.	19	12	11	8	4.9	0.0	0.0
Savannah	65	150	194	29.94	30.01	−.02	81.2	−0.3	99	23	90	68	3	73	25	74	72	82	8.09	+1.9	16	6,484	sw.	42	w.	24	11	9	11	5.3	0.0	0.0
Jacksonville	43	209	245	29.98	30.03	.00	81.2	−0.9	94	24	89	68	12	73	22	74	72	83	12.17	+6.0	18	6,728	sw.	41	w.	12	6	8	17	6.7	0.0	0.0
Florida Peninsula							**82.8**	**+0.6**										**76**	**6.95**	**+0.9**										**5.8**		
Key West	22	10	64	29.99	30.02	−.01	84.6	+1.1	92	24	90	75	26	79	15	76	74	72	2.02	−1.6	13	6,368	se.	39	sw.	26	7	21	3	4.8	0.0	0.0
Miami	25	71	79	30.01	30.04	-----	82.0	+0.1	94	17	88	71	18	76	19	76	74	76	8.31	+2.1	19	4,934	se.	31	nw.	18	6	16	9	6.0	0.0	0.0
Sand Key	23	39	72	30.00	30.03	.00	82.4	-----	88	29	85	73	27	80	12	76	73	72	1.12	-----	8	8,165	se.	39	se.	30	11	15	5	4.7	0.0	0.0
Tampa	35	79	87	29.99	30.02	−.02	81.9	+0.7	94	20	89	70	7	74	22	75	74	82	10.52	+2.1	17	3,670	e.	26	e.	29	0	14	17	7.5	0.0	0.0
East Gulf States							**80.5**	**−0.1**										**74**	**3.58**	**−1.7**										**4.7**		
Atlanta	1,174	190	216	28.82	30.03	+.01	78.2	+0.1	97	22	87	61	3	70	22	70	67	74	4.82	+0.1	14	5,768	nw.	40	nw.	14	12	6	13	5.4	0.0	0.0
Macon	370	78	87	29.62	30.01	−.01	80.0	−1.2	99	23	90	65	27	70	27	72	69	74	2.08	−2.6	13	3,357	n.	33	nw.	25	8	10	13	5.7	0.0	0.0
Thomasville	273	49	58	29.73	30.02	−.01	80.4	−1.4	97	20	90	65	3	71	25	73	71	80	4.51	−0.8	20	2,385	sw.	19	sw.	25	3	13	15	7.1	0.0	0.0
Apalachicola	36	42	49	29.97	30.01	-----	80.9	-----	92	23	87	70	11	74	20	76	74	82	7.17	-----	16	4,197	w.	31	n.	23	9	16	6	5.1	0.0	0.0
Pensacola	56	149	185	29.96	30.02	+.02	80.2	−0.8	95	20	87	64	2	74	20	74	72	78	8.40	+1.1	12	7,493	s.	49	ne.	16	6	16	9	5.5	0.0	0.0
Anniston	741	9	57	29.27	30.05	+.03	78.4	+0.5	98	22	90	55	2	66	33	----	----	----	1.20	−3.5	9	2,635	n.	24	nw.	16	15	14	2	3.5	0.0	0.0
Birmingham	700	11	48	29.29	30.04	+.03	79.8	−0.4	99	22	90	57	2	69	27	69	66	70	1.69	−3.0	8	3,431	n.	29	nw.	16	17	12	2	3.5	0.0	0.0
Mobile	57	125	161	29.96	30.02	+.01	82.0	+1.3	100	23	91	62	3	73	26	74	71	75	4.31	−2.7	11	5,892	sw.	38	nw.	25	7	21	3	4.9	0.0	0.0
Montgomery	223	100	112	29.78	30.02	.00	81.0	−0.7	99	23	91	63	2	71	28	73	71	78	6.58	+1.9	10	3,793	se.	33	nw.	14	12	14	5	4.6	0.0	0.0
Corinth	469	6	----	-----	-----	-----	79.7	-----	101	22	92	54	3	68	32	----	----	----	0.48	-----	5	-----	s.	----	----	----	11	20	----	----	0.0	0.0
Meridian	375	85	93	29.62	30.00	−.02	80.4	0.0	100	23	91	57	3	70	28	71	66	68	2.99	−1.5	7	3,240	sw.	23	sw.	12	21	9	1	3.3	0.0	0.0
Vicksburg	247	65	73	29.76	30.04	+.04	81.6	+0.3	100	24	91	59	2	72	23	71	67	68	0.22	−4.2	3	4,030	sw.	19	w.	16	17	12	2	3.6	0.0	0.0
New Orleans	53	76	84	29.96	30.01	+.01	84.0	+1.6	100	24	92	68	2	76	29	74	70	68	2.56	−3.9	10	4,264	sw.	25	sw.	18	8	21	2	4.5	0.0	0.0
West Gulf States							**81.8**	**−0.7**										**67**	**0.49**	**−2.6**										**3.4**		
Shreveport	249	77	93	29.74	30.00	+.02	83.8	+0.6	104	24	94	60	6	73	28	70	64	57	T.	−3.7	0	4,727	s.	20	s.	20	24	7	0	2.3	0.0	0.0
Bentonville	1,303	11	44				74.6	−3.9	94	23	85	49	3	64	28				6.94		11	2,818	s.	18	s.	12	19	5	7		0.0	0.0
Fort Smith	457	79	94	29.51	29.98	+.01	81.0	−0.5	101	24	91	57	2	71	27	70	65	63	1.38	−2.5	6	4,728	e.	24	nw.	18	11	12	8	5.0	0.0	0.0
Little Rock	357	136	144	29.63	30.00	+.01	79.9	−1.0	100	23	90	58	2	70	27	69	65	64	1.25	−2.7	6	4,918	s.	48	sw.	15	16	9	6	3.9	0.0	0.0
Brownsville	57	53	61	29.89	29.96		83.1	−0.5	96	25	90	68	4	76	21	75	73	79	1.40		5	6,471	s.	24	s.	19	21	9	1	2.8	0.0	0.0
Corpus Christi	20	11	73	29.98	30.00	+.04	82.6	−0.1	91	16	88	71	3	77	16	76	74	79	0.66	−1.0	2	10,388	s.	35	se.	18	17	11	3	3.7	0.0	0.0
Dallas	512	109	117	29.46	30.00		83.7		102	24	94	56	5	74	27				0.47		2	6,315	s.	31	ne.	10	17	11	3	3.7	0.0	0.0
Fort Worth	670	106	114	29.26	29.95	−.01	83.6	0.0	102	24	94	56	5	74	26	70	63	57	0.96	−2.1	2	7,413	s.	27	se.	10	16	9	6	4.0	0.0	0.0
Galveston	54	106	114	29.97	30.03	+.05	82.7	−0.7	95	25	87	69	5	78	18	75	72	75	T.	−4.0	0	7,222	s	23	s.	19	26	4	1	1.9	0.0	0.0
Groesbeck	461	11	25	29.52	29.99		82.0		99	24	93	59	6	71	33				0.19		1	7,344	s.	34	sw.	19	17	12	2	3.7	0.0	0.0
Houston	138	111	121	29.87	30.01		83.0	−0.7	101	25	92	66	5	74	27				2.60		6	4,487	s.	21	ne.	25	15	16	0	3.6	0.0	0.0
Palestine	510	64	72	29.48	30.00	+.03	81.8	−0.4	99	24	92	60	4	72	30	71	66	63	0.07	−2.9	1	5,211	s.	22	sw.	19	14	16	1	3.6	0.0	0.0
Port Arthur	34	58	66	29.97	30.01		82.6		97	24	90	64	3	76	21	74	70	71	0.35		3	6,278	s.	24	s.	18	26	5	0	1.8	0.0	0.0
San Antonio	693	119	132	29.26	29.98	+.03	82.5	−1.3	101	25	91	64	2	72	30	71	67	65	0.05	−2.2	1	5,922	se.	28	e.	26	19	12	0	3.1	0.0	0.0
Taylor	583	55	63	29.42	30.03	+.07	83.2	+0.5	101	25	93	62	5	73	29				0.01	−2.6	1	6,927	s.	26	s.	19	12	18	1	4.0	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, July, 1924*—Continued

Districts and stations	Elevation of instruments			Pressure			Temperature of the air												Precipitation			Wind										
	Barometer above sea level	Thermometer above ground	Anemometer above ground	Station, reduced to mean of 24 hours	Sea level, reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Maximum	Date	Mean maximum	Minimum	Date	Mean minimum	Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Total	Departure from normal	Days with .01, or more	Total movement	Prevailing direction	Maximum velocity: Miles per hour	Maximum velocity: Direction	Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	° F		° F	°F.		° F	°F.	°F.	°F.	%	In.	In.		Miles								0-10	In.	In.
Ohio Valley and Tennessee							**73.7**	**−2.7**										**68**	**2.80**	**−1.2**										**4.8**		
Chattanooga	762	189	213	29.21	30.00	−.02	77.6	−0.8	96	22	87	60	2	68	25	68	64	68	2.92	−1.0	12	3,950	w.	38	nw.	23	12	14	5	4.7	0.0	0.0
Knoxville	996	102	111	28.98	30.01	−.01	75.6	−1.5	94	22	85	59	3	66	27	68	65	74	2.45	−1.8	12	3,427	ne.	20	n.	4	5	11	15	6.7	0.0	0.0
Memphis	399	76	97	29.60	30.01	+.01	79.8	−0.9	97	22	88	59	4	72	26	69	64	62	0.99	−2.5	5	4,637	n.	31	n.	24	18	9	4	3.7	0.0	0.0
Nashville	546	168	191	29.46	30.04	+.03	76.5	−2.6	94	21	86	55	2	67	29	68	64	69	4.36	0.0	8	4,944	nw.	36	nw.	17	16	10	5	4.1	0.0	0.0
Lexington	989	193	230	28.98	30.03	+.02	73.2	−2.7	90	22	82	53	3	65	22				2.77	−1.7	9	7,510	sw.	38	sw.	12	15	11	5	4.2	0.0	0.0
Louisville	525	188	234	29.46	30.04	+.04	74.7	−3.9	93	21	84	55	3	66	23	65	60	65	1.47	−2.3	8	5,808	n.	28	sw.	14	11	16	4	4.4	0.0	0.0
Evansville	431	139	175	29.57	30.03	+.03	75.6	−3.3	95	21	85	54	2	66	24	67	62	65	2.70	−1.1	7	5,946	sw.	40	w.	14	5	21	5	5.3	0.0	0.0
Indianapolis	822	194	230	29.15	30.02	+.03	72.9	−2.8	91	20	82	51	3	64	25	64	58	64	1.75	−2.4	9	6,636	s.	42	s.	27	9	19	3	4.7	0.0	0.0
Royal Center	736	11	55	29.23	30.02		68.8		90	20	80	46	3	58	30				3.64		10	5,113	sw.	38	se.	27	8	14	9	5.6	0.0	0.0
Terre Haute	575	96	129	29.40	30.01		73.4		93	21	83	52	3	64	26	64	59	64	1.24		7	5,547	s.	24	nw.	24	4	21	6	5.5	0.0	0.0
Cincinnati	628	11	51	29.36	30.02	+.02	72.4	−2.7	92	30	83	50	3	62	27		63	70	1.29	−2.2	9	3,789	sw.	36	s.	12	13	14	4	4.7	0.0	0.0
Columbus	824	179	222	29.17	30.03	+.03	71.4	−3.5	91	29	81	50	3	62	24	64	59	68	2.98	−0.7	8	5,589	s.	46	nw.	30	16	9	6	4.3	0.0	0.0
Dayton	899	137	173	29.07	30.00		72.0	−3.4	90	30	82	50	3	62	26	63	58	64	2.78	−0.5	9	5,136	sw.	37	w.	30	13	17	1	3.9	0.0	0.0
Elkins	1,947	59	67	28.04	30.04	+.03	67.2	−3.1	87	21	79	46	18	56	33	61	60	84	5.86	+1.2	15	2,628	w.	28	n.	31	5	17	9	5.9	0.0	0.0
Parkersburg	638	77	84	29.39	30.04	+.03	72.6	−2.8	93	29	84	52	18	62	31	64	60	70	3.75	−0.9	13	2,823	se.	45	w.	4	14	9	8	4.6	0.0	0.0
Pittsburgh	842	353	410	29.13	30.01	+.01	71.1	−3.5	89	29	81	52	2	61	28	63	59	71	3.10	−1.3	12	5,766	sw.	44	w.	12	11	11	9	4.8	0.0	0.0
Lower Lake Region							**69.1**	**−2.5**										**67**	**3.06**	**−0.3**										**4.2**		
Buffalo	767	247	280	29.18	29.99	+.02	67.6	−2.2	88	21	75	50	18	60	25	61	58	73	4.10	+0.7	12	10,790	sw.	60	w.	12	14	10	7	4.6	0.0	0.0
Canton	448	10	61	29.45	29.92		67.4	−3.1	87	21	78	47	26	57	31				2.87	−0.4	12	6,481	sw.	36	nw.	17	19	9	3	3.4	0.0	0.0
Oswego	335	76	91	29.60	29.96	.00	66.7	−3.7	87	12	74	50	2	59	26	61	57	72	2.43	−0.8	13	5,713	w.	27	nw	25	16	7	8	4.1	0.0	0.0
Rochester	523	86	102	29.43	29.99	+.02	69.0	−1.7	89	12	78	50	2	60	28	61	56	66	3.98	+0.9	13	5,454	w	29	w.	12	14	10	7	4.6	0.0	0.0
Syracuse	597	97	113	29.35	30.00	+.03	68.9	−1.9	88	29	78	50	2	60	26				4.95	+1.3	11	5,085	s.	36	w.	16	11	11	9	5.2	0.0	0.0
Erie	714	130	166	29.24	30.00	+.02	69.1	−1.9	90	21	77	51	2	61	26	63	59	69	3.38	+0.2	13	8,241	nw.	47	sw.	12	13	13	5	4.4	0.0	0.0
Cleveland	762	190	201	29.20	30.01	+.02	69.2	−2.2	88	28	76	51	19	62	27	62	58	66	3.10	−0.4	11	7,654	n.	46	nw.	12	14	11	6	4.4	0.0	0.0
Sandusky	629	62	70	29.34	30.01	+.02	70.8	−2.6	91	29	79	53	1	63	26				2.35	−1.4	12	4,948	sw.	41	nw.	24	12	13	6	4.4	0.0	0.0
Toledo	628	208	243	29.34	30.01	+.02	70.6	−2.6	91	29	80	50	1	61	24	62	57	64	2.63	−0.6	13	8,605	sw.	52	sw.	28	21	5	5	3.2	0.0	0.0
Fort Wayne	856	113	124	29.12	30.03		70.4	−3.1	90	29	80	51	1	61	26	62	58	67	1.20		7	5,230	sw.	26	nw.	24	10	13	8	4.9	0.0	0.0
Detroit	730	218	258	29.24	30.02	+.04	69.9	−2.2	90	23	79	52	2	61	24	61	55	62	0.78	−2.7	6	6,675	sw.	30	w.	24	19	7	5	3.4	0.0	0.0
Upper Lake Region							**65.2**	**−3.1**										**72**	**3.33**	**+0.2**										**4.2**		
Alpena	609	13	92	29.33	29.99	+.02	63.1	−2.8	87	23	72	44	18	54	34	59	55	74	4.25	+1.2	11	7,304	nw.	34	nw.	10	6	18	7	5.7	0.0	0.0
Escanaba	612	54	60	29.32	29.98	+.01	62.4	−3.6	86	22	70	42	18	54	26	58	54	76	2.76	−0.6	14	6,514	s.	32	ne.	30	12	8	11	4.7	0.0	0.0
Grand Haven	632	54	89	29.32	29.99	+.01	64.6	−4.1	84	21	72	45	18	57	24	60	56	73	2.93	+0.4	10	6,652	s.	26	w.	21	15	11	5	4.1	0.0	0.0
Grand Rapids	707	70	87	29.25	30.01	+.03	68.9	−3.7	90	21	79	47	18	59	28	61	56	65	3.37	+0.7	12	3,485	w.	18	nw.	21	10	8	13	5.3	0.0	0.0
Houghton	668	62	99	29.24	29.96	.00	61.8	−3.7	89	11	72	42	31	52	32				3.43	+0.3	10	6,932	w.	36	w.	12	12	11	8	5.1	0.0	0.0
Lansing	878	11	62	29.07	30.00		67.4	−3.5	90	23	79	45	18	56	33	61	57	74	2.68	−0.5	14	2,998	w.	24	sw.	27	15	11	5	4.3	0.0	0.0
Ludington	637	60	66	29.31	30.00	+.04	62.4		83	21	70	45	3	55	26	58	55	76	3.80		9	6,376	s.	32	nw.	21	18	6	7	3.7	0.0	0.0
Marquette	734	77	111	29.20	30.00	+.04	61.8	−3.1	89	11	70	43	3	54	26	57	53	74	1.55	−1.6	13	6,151	nw.	29	w.	22	7	10	14	6.2	0.0	0.0
Port Huron	638	70	120	29.31	30.00	+.02	67.1	−1.7	90	23	76	47	2	58	27	61	57	72	3.18	+0.4	10	6,933	ne.	31	sw.	9	15	12	4	3.5	0.0	0.0
Saginaw	641	69	77	29.31	30.00		67.2	−3.9	92	23	78	45	18	56	30	61	56	69	5.19	+1.5	11	5,167	sw.	29	sw.	9	10	12	9	5.6	0.0	0.0
Sault Sainte Marie	614	11	52	29.28	29.97	.00	61.7	−2.1	84	11	72	44	2	52	37	57	53	75	2.26	−0.5	12	4,961	nw.	32	nw.	22	7	19	5	5.2	0.0	0.0
Chicago	823	140	310	29.15	30.02	+.04	70.2	−3.7	91	28	77	53	1	64	24	62	57	64	3.66	0.0	10	6,840	ne.	32	nw.	24	13	8	10	4.5	0.0	0.0
Green Bay	617	109	144	29.31	29.97	.00	66.8	−3.2	88	28	77	47	1	57	29	61	57	73	2.96	−0.6	9	6,682	s.	40	n.	30	8	14	9	5.5	0.0	0.0
Milwaukee	681	125	139	29.27	30.00	+.03	67.6	−2.5	89	23	75	49	1	60	25	61	57	69	2.49	−0.5	8	6,151	w.	47	n.	21	15	6	10	4.6	0.0	0.0
Duluth	1,133	11	47	28.78	29.98	+.03	62.4	−1.5	85	11	73	42	31	52	32	57	54	81	5.87	+2.2	11	7,228	ne.	58	w.	11	11	13	7	4.8	0.0	0.0
North Dakota							**66.8**	**−1.9**										**64**	**1.54**	**−1.4**										**3.4**		
Moorhead	940	50	58	28.95	29.95	+.01	66.6	−1.5	90	29	78	45	13	55	35	60	54	66	1.25	−2.5	9	5,511	s.	23	nw.	12	21	8	2	2.6	0.0	0.0
Bismarck	1,674	8	57	28.22	29.98	+.05	67.5	−2.3	91	15	80	47	13	56	38	59	52	62	1.40	−0.7	8	6,373	nw.	34	se.	20	17	9	5	3.8	0.0	0.0
Devils Lake	1,478	11	44	28.40	29.95	+.02	66.2	−1.9	89	15	78	39	13	54	34	58	52	65	1.31	−2.5	10	6,510	s.	32	nw.	27	16	12	3	3.7	0.0	0.0
Ellendale	1,457	10	56	28.43	29.97		66.7		93	29	80	43	17	53	44				1.53		5	9,387	s.	46	se.	18	16	11	4	3.6	0.0	0.0
Grand Forks	835	12	89				64.0		88	5	76	41	17	52	39				1.86		7		se.	35	sw.	21	21	5	5		0.0	0.0
Williston	1,878	41	48	27.97	29.91	−.01	66.9	−2.0	94	10	78	47	13	56	34	58	53	64	2.18	+0.2	11	5,174	se.	37	e.	16	17	10	4	3.4	0.0	0.0
Upper Mississippi Valley							**71.4**	**−3.7**										**70**	**3.12**	**−0.5**										**4.6**		
Minneapolis	918	102	208	28.98	29.95		69.9	−2.4	90	22	80	47	31	60	27				1.22	−2.6	10	6,986	nw.	29	nw.	9	12	13	6	4.4	0.0	0.0
St. Paul	837	236	261	29.08	29.98	+.03	69.0	−3.1	89	28	80	49	31	58	29				1.73	−1.7	10	7,488	sw.	38	s.	23	11	16	4	4.1	0.0	0.0
La Crosse	714	11	48	29.23	29.98	+.02	69.2	−3.6	91	28	80	47	2	58	33				1.94	−2.1	11	2,711	se.	19	nw.	20	10	17	4	4.7	0.0	0.0
Madison	974	70	78	28.98	30.00	+.03	68.3	−3.8	86	23	77	49	18	59	24	62	59	75	5.01	+1.0	12	4,990	sw.	35	ne.	25	9	15	7	5.2	0.0	0.0
Wausau	1,247	4		28.68	30.00		65.2		86	28	76	42	1	54	30				4.08		13		nw.				17	3	11	4.5	0.0	0.0
Charles City	1,015	10	49	28.94	29.99	+.03	68.2	−5.3	89	28	79	45	2	57	30	61	57	70	3.19	−0.4	14	3,663	se.	28	nw.	23	14	13	4	4.1	0.0	0.0
Davenport	606	71	79	29.35	30.00	+.03	72.0	−3.3	93	21	82	50	2	62	27	63	59	67	3.76	+0.2	11	4,106	s.	28	nw.	21	13	12	6	4.7	0.0	0.0
Des Moines	861	84	97	29.10	29.99	+.03	71.9	−3.5	93	28	82	51	3	61	29	64	60	69	0.98	−2.9	9	4,401	sw.	33	sw.	16	12	13	6	4.3	0.0	0.0
Dubuque	700	81	96	29.25	29.99	+.02	70.0	−4.1	88	16	80	49	1	60	29	62	58	69	4.11	−0.2	11	3,569	s.	39	nw.	21	9	12	10	5.7	0.0	0.0
Keokuk	614	64	78	29.35	30.02	+.04	72.7	−4.2	94	16	82	52	4	63	27	66	61	68	4.85	+0.8	12	3,879	nw.	25	nw.	24	11	14	6	4.8	0.0	0.0
Cairo	358	87	93	29.63	30.00	.00	76.0	−3.6	92	21	84	56	3	68	21	68	65	73	3.73	+0.3	11	4,207	n.	33	nw.	17	12	12	7	4.8	0.0	0.0
Peoria	609	11	45	29.37	30.03	+.05	71.0	−4.4	94	21	82	49	1	60	29	65	61	72	5.59	+2.6	9	3,250	s.	21	w.	29	20	7	4	3.2	0.0	0.0
Springfield, Ill	636	10	91	29.33	29.99	+.01	73.2	−3.3	95	21	83	51	18	63	30	66	62	71	1.71	−1.2	8	4,490	s.	24	n.	17	13	11	7	4.5	0.0	0.0
Hannibal	534	74	109	29.45	30.01	+.03	72.6	−4.2	93	16	83	50	4	62	29				2.23	−1.5	13	4,850	sw.	27	sw.	9	12	11	8	4.8	0.0	0.0
St. Louis	568	265	303	29.41	30.01	+.02	75.0	−3.6	93	21	83	55	3	67	22	66	61	65	3.62	+0.2	12	6,923	s.	54	sw	17	9	16	6	4.9	0.0	0.0
Missouri Valley							**72.5**	**−3.3**										**66**	**3.69**	**−0.1**										**3.8**		
Columbia, Mo	784	11	84	29.18	30.00	+.02	72.2	−4.7	92	21	82	50	4	62	28				5.70	+2.0	15	4,286	s.	50	nw.	16	13	11	7	4.5	0.0	0.0
Kansas City	963	161	181	28.98	29.98	+.01	74.6	−3.5	97	16	83	53	2	66	33	67	63	68	3.41	−1.4	15	5,976	s.	58	n.	16	12	15	4	4.3	0.0	0.0
St. Joseph	967	11	49	28.97	29.98		73.8		98	16	84	50	3	64	32	65	61	69	4.44		12	4,735	se.	43	ne.	17	20	8	3	3.2	0.0	0.0
Springfield, Mo	1,324	98	104	28.64	30.02	+.04	73.2	−3.6	91	16	81	53	3	65	23	66	63	73	5.92	+1.1	13	5,929	s.	35	nw.	14	18	10	3	3.1	0.0	0.0
Iola	984	11	50	28.96	29.98	+.01	74.8	−3.3	96	16	86	49	3	64	32				7.55	+3.6	13	3,673	s.	28	n.	17	15	12	4	4.2	0.0	0.0
Topeka	987	92	107				75.2	−2.6	100	16	86	51	3	65	29				5.30	+0.4	13	6,175	s.	40	n.	17	13	15	3	3.8	0.0	0.0
Drexel	1,299	10	54	28.62	29.98		70.5		90	23	81	49	2	60	28				3.63		12	5,883	s.	57	sw.	27	15	11	5	4.0	0.0	0.0
Lincoln	1,189	11	84	28.74	29.97	+.02	72.9	−3.6	96	23	84	49	3	62	30	64	59	66	4.66	+0.8	11	6,111	se.	40	nw.	16	15	12	4	4.1	0.0	0.0
Omaha	1,105	115	122	28.83	29.99	+.04	73.2	−3.5	96	23	83	52	2	64	28	65	60	66	2.79	−1.5	12	4,689	s.	42	nw.	11	14	15	2	3.7	0.0	0.0
Valentine	2,598	47	54	27.30	29.97	+.04	71.2	−2.5	96	29	84	49	2	59	35	60	53	58	0.98	−2.4	9	7,269	s.	37	ne.	16	16	11	4	3.5	0.0	0.0
Sioux City	1,135	94	164	28.80	29.99	+.04	71.4	−2.9	92	27	82	49	4	61	31	62	57	64	2.87	−0.7	8	7,110	s.	59	e.	15	15	13	3	3.8	0.0	0.0
Huron	1,306	59	74	28.62	29.99	+.05	69.4	−2.4	92	29	82	49	17	57	42	61	55	64	2.55	−0.4	6	6,501	se.	33	se.	19	22	6	3	3.1	0.0	0.0
Pierre	1,572	70	75	28.31	29.94	+.01	71.6	−3.7	97	22	84	50	17	60	38	62	56	62	1.11	−1.2	7	7,165	e.	50	nw.	18	17	8	6	3.6	0.0	0.0
Yankton	1,233	49	57	28.68	29.97	+.03	70.8	−3.4	93	27	82	50	14	60	31				1.48	−2.0	7	4,874	w.	40	nw.	15	14	14	3	4.1	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, July, 1924*—Continued.

Districts and stations.	Elevation of instruments.			Pressure.			Temperature of the air.									Mean wet thermometer.	Mean temperature of the dew point.	Mean relative humidity.	Precipitation.			Wind.					Clear days.	Partly cloudy days.	Cloudy days.	Average cloudiness, tenths.	Total snowfall.	Snow, sleet, and ice on ground at end of month.
	Barometer above sea level.	Thermometer above ground.	Anemometer above ground.	Station, reduced to means of 24 hours.	Sea level, reduced to mean of 24 hours.	Departure from normal.	Mean max. + mean min. ÷ 2.	Departure from normal.	Maximum.	Date.	Mean maximum.	Minimum.	Date.	Mean minimum.	Greatest daily range.				Total.	Departure from normal.	Days with 0.01, or more.	Total movement.	Prevailing direction.	Maximum velocity. Miles per hour.	Maximum velocity. Direction.	Maximum velocity. Date.						
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F		°F	°F.	°F		°F.	°F.	°F.	%	In.	In.		Miles.								0–10	In.	In.
Northern Slope							**67.7**	**−0.1**										**52**	**1.20**	**−0.4**										**3.4**		
Billings	3,140	5	—	—	—	—	68.6	—	100	15	86	42	19	51	52	—	—	—	1.96	—	9	—	nw.	—	—	—	17	7	7	—	0.0	0.0
Havre	2,505	11	44	27.33	29.92	+.01	68.6	+0.3	95	27	83	45	12	54	47	57	49	56	0.70	−1.2	4	4,312	e.	27	nw.	28	24	5	2	2.3	0.0	0.0
Helena	4,110	87	112	25.82	29.92	−.01	67.9	+2.2	96	3	82	42	19	54	45	52	41	44	0.89	−0.2	9	6,260	sw.	31	s.	14	16	11	4	3.7	0.0	0.0
Kalispell	2,973	48	56	26.90	29.90	−.03	65.6	+1.5	95	2	80	43	7	51	46	51	39	46	0.97	+0.1	4	4,517	nw.	34	se.	14	20	8	3	3.4	0.0	0.0
Miles City	2,371	48	55	27.46	29.96	+.04	72.2	−0.7	102	15	85	48	24	59	38	59	50	53	0.39	−1.0	4	4,220	ne.	30	n.	18	19	8	4	2.9	0.0	0.0
Rapid City	3,259	50	58	26.63	29.97	+.04	69.6	−1.4	94	10	82	49	2	57	40	58	50	52	2.33	−0.2	8	5,630	se.	42	n.	18	14	13	4	3.6	0.0	0.0
Cheyenne	6,088	84	101	24.10	29.92	.00	65.8	−0.9	89	15	79	42	9	52	35	54	46	55	1.12	−0.9	7	7,192	s.	40	n.	31	13	12	6	4.2	0.0	0.0
Lander	5,372	60	68	24.70	29.93	+.01	67.6	+0.2	90	26	84	40	21	51	40	52	40	44	0.04	−0.8	1	4,106	sw.	50	sw.	20	14	16	1	3.5	0.0	0.0
Sheridan	3,790	10	47	26.14	29.97	—	66.0	—	96	15	82	38	24	50	49	55	48	58	1.08	—	7	3,198	s.	35	nw.	7	18	12	1	2.9	0.0	0.0
Yellowstone Park	6,200	11	48	23.98	29.98	+.06	59.8	−1.7	87	2	76	34	19	44	42	47	38	55	3.39	+2.2	13	5,307	s.	37	nw.	22	11	16	4	4.3	0.0	0.0
North Platte	2,821	11	51	27.12	29.99	+.06	72.6	−0.3	99	16	86	49	2	60	39	61	55	62	1.00	−1.7	6	4,819	e.	37	w.	20	18	10	3	3.0	0.0	0.0
Middle Slope							**75.5**	**−1.7**										**58**	**2.59**	**−0.4**										**4.2**		
Denver	5,292	106	113	24.80	29.94	+.03	71.8	−0.4	93	15	84	55	25	60	35	57	48	49	0.33	−1.3	6	5,061	s.	32	w.	17	14	14	3	3.7	0.0	0.0
Pueblo	4,685	80	86	25.34	29.91	.00	74.2	0.0	97	23	89	53	3	60	41	58	49	51	0.84	−1.1	5	4,681	e.	36	nw.	1	10	21	0	4.2	0.0	0.0
Concordia	1,392	50	58	28.50	29.94	−.01	75.4	−2.6	104	16	87	50	3	64	38	65	58	60	3.55	−0.1	13	5,281	s.	42	n.	16	12	17	2	4.4	0.0	0.0
Dodge City	2,509	11	51	27.43	29.98	+.05	75.2	−3.2	100	29	88	49	5	62	34	64	59	66	3.64	+0.3	7	7,334	se.	37	sw.	11	17	12	2	3.0	0.0	0.0
Wichita	1,358	139	158	28.55	29.95	−.01	77.0	−2.4	100	16	87	53	3	67	26	66	60	62	3.64	0.0	11	8,802	s.	40	s.	8	13	17	1	4.1	0.0	0.0
Broken Arrow	765	11	52	29.19	30.00	—	77.4	—	99	16	88	53	5	67	28	—	—	—	7.57	—	9	7,565	s.	41	n.	24	10	11	10	5.2	0.0	0.0
Muskogee	652	4	—	—	—	—	79.6	—	102	24	92	53	3	68	32	—	—	—	3.90	—	7	—	se.	—	—	—	17	2	12	—	0.0	0.0
Oklahoma City	1,214	10	47	28.72	29.97	+.01	79.2	−1.4	102	24	90	57	4	69	34	68	62	61	3.55	−0.1	11	6,602	s.	31	s.	24	8	14	9	5.0	0.0	0.0
Southern Slope							**80.2**	**−1.0**										**58**	**1.88**	**−0.6**										**3.9**		
Abilene	1,738	10	52	28.18	29.93	.00	82.0	−0.8	103	12	92	58	5	71	33	68	61	55	0.64	−1.8	7	7,527	s.	27	s.	7	13	6	12	4.9	0.0	0.0
Amarillo	3,676	10	49	26.32	29.96	+.04	75.4	−1.4	97	13	86	52	5	64	32	64	59	64	3.66	+0.5	6	6,966	se.	29	e.	3	18	11	2	4.0	0.0	0.0
Del Rio	944	64	71	28.97	29.94	+.04	85.2	−1.1	104	25	95	68	6	75	32	—	—	—	0.48	−1.8	3	8,734	se.	34	e.	25	21	8	2	3.5	0.0	0.0
Roswell	3,566	75	85	26.37	29.89	+.01	78.0	−0.9	100	13	91	55	3	65	35	63	56	56	2.76	+0.6	6	5,637	e.	33	nw.	24	21	8	2	3.3	0.0	0.0
Southern Plateau							**78.9**	**−0.1**										**42**	**0.92**	**−0.3**										**2.7**		
El Paso	3,762	110	133	26.17	29.82	−.02	81.0	−0.1	101	13	93	62	2	69	32	64	55	47	3.00	+0.9	13	7,712	se.	54	ne.	1	16	15	0	3.5	0.0	0.0
Santa Fe	7,013	38	53	23.37	29.88	.00	67.8	−1.2	86	13	80	49	5	56	31	54	46	54	1.53	−1.2	15	4,389	e.	26	e.	15	8	21	2	4.5	0.0	0.0
Flagstaff	6,907	10	59	—	—	—	65.0	0.0	86	2	79	38	21	51	43	—	—	52	2.91	—	11	5,386	w.	31	w.	28	9	22	0	—	0.0	0.0
Phoenix	1,108	11	81	28.67	29.78	.00	90.2	+0.4	110	31	103	65	21	78	40	70	59	39	0.09	−1.0	3	3,884	w.	30	sw.	6	13	16	2	3.5	0.0	0.0
Yuma	141	9	54	29.62	29.76	.00	91.6	+0.8	112	26	106	67	22	77	40	70	59	40	T.	−0.1	0	4,155	s.	29	se.	5	28	3	0	0.9	0.0	0.0
Independence	3,957	5	25	25.95	29.89	+.06	77.8	−0.3	101	1	94	55	14	62	39	53	28	19	T.	−0.1	0	5,976	se.	38	w.	3	29	2	0	0.9	0 0	0.6
Middle Plateau							**73.8**	**+1.4**										**30**	**0.49**	**−0.1**										**2.7**		
Reno	4,532	74	81	25.47	29.87	.00	71.6	+4.1	97	2	89	46	13	54	46	49	30	28	0.02	−0.3	1	5,885	w.	31	w.	31	27	3	1	1.3	0.0	0.0
Tonopah	6,090	12	20	—	—	—	74.2	—	93	1	86	56	12	63	29	51	30	23	0.03	—	1	—	se.	—	—	—	—	—	—	—	0.0	0.0
Winnemucca	4,344	18	56	25.60	29.90	.00	72.1	+1.5	101	2	91	43	22	54	50	50	30	27	0.31	+0.1	1	4,819	sw.	33	sw.	3	26	5	0	1.8	0.0	0.0
Modena	5,479	10	43	24.66	29.89	+.03	70.4	−0.2	96	1	88	44	14	53	45	50	34	37	1.09	−0.2	7	8,840	sw.	47	nw.	10	19	10	2	2.8	0.0	0.0
Salt Lake City	4,360	163	203	25.60	29.86	.04	77.5	+1.8	96	31	89	56	21	66	34	56	40	30	0.45	−0.1	4	6,246	s.	38	nw.	6	21	8	2	2.4	0.0	0.0
Grand Junction	4,602	60	68	25.38	29.88	−.01	77.6	−0.1	97	1	91	57	11	64	34	57	42	36	0.57	+0.1	7	4,398	se.	28	sw.	9	17	11	3	4.0	0.0	0.0
Northern Plateau							**72.5**	**+1.5**										**35**	**0.67**	**+0.2**										**3.0**		
Baker	3,471	48	53	26.44	29.96	+.01	66.8	+1.2	98	1	84	40	6	50	44	50	36	39	0.04	−0.4	2	4,538	nw.	29	sw.	14	13	13	5	4.0	0.0	0.0
Boise	2,739	78	86	27.11	29.90	−.03	74.0	+1.1	105	2	89	48	16	58	39	54	36	30	T.	−0.2	0	3,936	nw.	25	w.	3	20	11	0	2.7	0.0	0.0
Lewiston	757	40	48	29.12	29.91	−.04	75.5	+1.5	107	26	91	51	7	60	45	—	—	—	0.70	+0.3	2	2,986	e.	28	nw.	14	21	6	4	2.5	0.0	0.0
Pocatello	4,477	60	68	25.47	29.88	−.04	72.0	+1.2	98	1	87	45	20	57	41	53	37	36	1.67	+1.0	8	5,732	se.	39	sw.	29	17	8	6	3.6	0.0	0.0
Spokane	1,929	101	110	27.92	29.92	−.04	71.4	+2.4	102	2	86	48	23	57	42	54	39	37	0.69	0.0	4	4,286	sw.	25	w.	14	16	12	3	3.2	0.0	0.0
Walla Walla	991	57	65	28.88	29.93	−.04	75.4	+1.4	104	1	88	52	16	62	37	56	41	35	0.90	+0.5	3	3,845	s.	24	se.	26	24	6	1	2.3	0.0	0.0
North Pacific Coast Region							**62.3**	**+0.3**										**68**	**0.42**	**−0.3**										**4.5**		
North Head	211	11	56	29.89	30.11	+.03	57.1	−0.1	77	24	61	49	24	53	28	54	52	87	0.30	−0.2	7	10,981	n.	44	nw.	19	7	5	19	7.3	0.0	0.0
Port Angeles	29	8	53	—	30.10	—	57.6	—	85	24	66	43	11	50	34	—	—	—	0.61	+0.2	4	5,242	sw.	29	sw.	5	17	4	10	—	0.0	0.0
Seattle	125	215	250	29.96	30.09	+.05	63.5	+0.4	91	24	73	50	10	54	29	56	50	67	0.51	−0.2	5	4,969	ne.	23	ne.	5	13	8	10	4.4	0.0	0.0
Tacoma	194	172	201	29.87	30.07	+.01	63.3	+0.5	88	24	73	48	10	54	30	—	—	—	0.67	0.0	5	5,651	n.	31	sw.	5	7	13	11	6.2	0.0	0.0
Tatoosh Island	86	9	57	29.99	30.09	+.04	54.8	−0.3	88	24	59	48	8	51	39	53	52	91	0.85	−0.9	10	7,915	s.	38	s.	24	7	14	10	5.6	0.0	0.0
Yakima	1,071	5	—	—	—	—	72.2	—	104	1	89	41	15	55	48	—	—	—	0.18	—	1	—	nw.	—	—	—	—	18	11	2	0.0	0.0
Medford	1,425	4	—	—	—	—	72.2	—	104	24	93	43	15	52	55	54	42	44	T.	—	0	—	nw.	15	se.	23	20	4	7	1.8	0.0	0.0
Portland, Oreg.	153	68	106	29.89	30.05	.00	67.0	+0.3	99	24	78	50	20	56	35	57	50	59	0.03	−0.6	3	4,564	nw.	23	n.	19	15	12	4	4.1	0.0	0.0
Roseburg	510	9	57	29.50	30.04	+.01	68.3	+0.9	99	23	85	45	7	52	47	57	48	57	T.	−0.3	0	3,135	n.	15	n.	21	20	11	0	2.2	0.0	0.0
Middle Pacific Coast Region							**64.1**	**−0.7**										**62**	**0.01**	**0.0**										**2.7**		
Eureka	62	73	89	30.00	30.07	+.02	54.6	−0.9	65	26	59	45	7	50	15	52	50	85	0.02	−0.1	2	4,896	n.	28	n.	15	11	14	6	4.7	0.0	0.0
Point Reyes	490	7	18	29.43	29.94	—	52.4	−1.3	63	24	56	46	16	49	11	—	—	—	0.00	—	0	19,189	nw.	65	nw.	18	8	7	16	6.5	0.0	0.0
Red Bluff	332	50	56	29.50	29.84	−.05	81.2	+0.4	107	2	97	57	12	66	37	60	43	33	0.00	0.0	0	4,176	se.	22	nw.	20	31	0	0	0.1	0.0	0.0
Sacramento	69	106	117	29.80	29.87	−.01	72.2	−1.0	102	2	88	50	12	56	39	59	49	53	T.	0.0	0	7,378	s.	23	sw.	11	31	0	0	0.4	0.0	0.0
San Francisco	155	208	243	29.79	29.96	+.01	59.0	+0.5	70	31	65	50	7	53	16	53	50	79	0.01	0.0	0	8,163	w.	34	w.	14	16	11	4	3.4	0.0	0.0
San Jose	141	12	110	29.81	29.96	—	65.0	−1.9	89	2	78	45	13	52	34	—	—	—	0.00	0.0	0	5,231	nw.	24	se.	19	30	1	0	1.0	0.0	0.0
South Pacific Coast Region							**69.8**	**−1.2**										**62**	**0.00**	**0.0**										**2.2**		
Fresno	327	89	98	29.51	29.85	+.02	80.5	−1.6	108	1	98	58	12	64	39	58	40	29	0.00	0.0	0	6,431	nw.	21	nw.	31	29	2	0	0.3	0.0	0.0
Los Angeles	338	159	191	29.57	29.93	+.03	69.4	−0.8	88	27	79	56	12	60	25	60	56	70	0.00	0.0	0	3,720	sw.	15	sw.	21	21	10	0	2.4	0.0	0.0
San Diego	87	62	70	29.84	29.93	+.01	67.0	−0.2	78	1	72	58	13	62	17	62	59	80	0.00	0.0	0	5,166	nw.	19	nw.	25	19	10	2	3.8	0.0	0.0
San Luis Obispo	201	32	40	29.76	29.98	+.03	62.4	−2.3	88	26	74	43	14	51	38	54	49	71	0.00	0.0	0	3,134	nw.	14	nw.	25	26	5	0	2.1	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54	29.95	30.04	—	79.8	−0.3	85	29	84	73	6	76	11	—	—	—	6.18	−0.2	17	12,762	e.	42	e.	29	9	20	2	4.8	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.82	29.86	+.02	79.2	−1.1	88	11	85	71	27	74	16	75	74	91	5.97	−1.4	16	4,386	nw.	27	se.	26	0	14	17	7.4	0.0	0.0
Colon	36	7	97	29.83	29.86	+.01	80.2	−0.1	90	1	86	73	27	75	16	76	75	91	20.63	+5.0	29	4,461	nw.	29	nw.	17	1	5	25	8.5	0.0	0.0
Alaska																																
Juneau	80	11	54	—	—	—	54.6	—	74	29	60	42	4	49	24	52	50	86	8.23	—	22	4,639	s.	30	se.	2	2	3	26	9.0	0.0	0.0

TABLE 2.—*Data furnished by the Canadian Meteorological Service, July, 1924*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure: Station reduced to mean of 24 hours	Pressure: Sea level reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Mean maximum	Temperature of the air: Mean minimum	Temperature of the air: Highest	Temperature of the air: Lowest	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Total snowfall
	Feet	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*In.*	*In.*	*In.*
Sydney, C. B. I	48	29.85	29.90	−.03	66.4	+4.1	77.1	55.7	88	50	1.23	−2.42	0.0
Halifax, N. S	88	29.82	29.92	−.04	67.1	+3.7	79.2	55.0	91	47	1.34	−2.71	0.0
Yarmouth, N. S	65	29.82	29.89	−.06	60.4	+0.9	68.3	52.4	78	46	1.60	−2.02	0.0
Charlottetown, P. E. I	38	29.82	29.86	−.04	66.5	+2.4	73.9	59.2	82	55	0.70	−2.79	0.0
Chatham, N. B	28	29.72	29.75	−.13	66.8	+1.8	79.7	53.9	91	45	3.56	−0.63	0.0
Father Point, Que	20	29.76	29.78	−.07	55.4	−2.2	64.8	46.1	82	38	4.86	+1.82	0.0
Quebec, Que	296	29.55	29.86	−.05	67.2	+1.7	76.7	57.8	87	49	3.79	−0.47	0.0
Montreal, Que	187	29.68	29.88	−.05	68.8	+0.3	77.8	59.8	85	51	6.04	+1.75	0.0
Ottawa, Ont	236	29.65	29.91	−.03	68.1	−1.4	79.7	56.5	88	50	3.94	+0.47	0.0
Kingston, Ont	285	29.64	29.94	−.03	66.4	−1.8	74.0	58.9	80	50	3.53	+0.64	0.0
Toronto, Ont	379	29.56	29.95	−.02	67.3	−0.7	77.7	56.9	88	48	4.17	+1.25	0.0
Cochrane, Ont	930				60.0		71.8	48.2	88	40	3.37		0.0
White River, Ont	1,244	28.63	29.93	−.01	56.7	−2.8	71.1	42.4	86	30	3.42	+0.62	0.0
Southampton, Ont	656	29.27			63.0	−1.7	71.7	54.3	86	42	4.39	+2.41	0.0
Parry Sound, Ont	688	29.27	29.95	−.01	64.4	−1.6	75.6	53.3	90	43	2.83	+0.21	0.0
Port Arthur, Ont	644	29.27	29.98	+.04	60.9	−1.1	70.7	51.2	89	40	3.34	−0.14	0.0
Winnipeg, Man	760	29.12	29.93	.00	66.0	0.0	77.4	54.7	91	38	2.99	−0.09	0.0
Minnedosa, Man	1,690	28.15	29.93	.00	65.0	+2.8	75.7	54.4	89	40	1.75	−0.85	0.0
Le Pas, Man	860				62.5		75.7	49.3	91	33	1.98		0.0
Qu'Appelle, Sask	2,115	27.69	29.90	−.02	64.0	+0.5	77.6	50.4	89	39	1.49	−0.99	0.0
Medicine Hat, Alb	2,144	27.60	29.80	−.10	71.9	+4.1	87.2	56.7	103	46	0.31	−1.78	0.0
Moose Jaw, Sask	1,759				66.0		80.6	51.5	95	41	1.96		0.0
Swift Current, Sask	2,392	27.41	29.88	−.03	65.4	−1.1	80.0	50.7	92	40	2.22	−0.22	0.0
Calgary, Alb	3,428	26.42	29.91	+.01	63.8	+3.2	80.3	47.4	92	38	2.51	−0.17	0.0
Banff, Alb	4,521	25.42	29.90	.00	58.8	+2.2	74.7	42.8	93	33	2.01	−1.23	0.0
Edmonton, Alb	2,150	27.62	29.85	−.05	64.0	+3.4	77.1	50.9	98	40	4.27	+1.24	0.0
Prince Albert, Sask	1,450	28.40	29.95	+.04	65.5	+3.6	78.3	52.7	93	43	1.18	−0.87	0.0
Battleford, Sask	1,592	28.18	29.89	−.01	66.8	+2.1	80.8	52.8	96	41	1.17	−1.17	0.0
Victoria, B. C	230	29.80	30.05	.00	59.8	−0.2	68.0	51.7	92	48	0.32	−0.08	0.0

LATE REPORTS, JUNE, 1924

Sydney, C. B. I	48	29.85	29.90	−.05	56.7	+1.3	67.0	46.3	78	36	2.76	−0.47	0.0
Halifax, N. S	88	29.80	29.90	−.05	59.2	+1.5	70.1	48.3	82	40	3.44	−0.32	0.0
Yarmouth, N. S	65	29.80	29.87	−.08	53.8	−1.2	61.8	45.8	70	40	2.33	−0.43	0.0
Charlottetown, P. E. I	38	29.82	29.86	−.06	57.6	+0.2	65.3	49.9	80	40	1.77	−0.90	0.0
Chatham, N. B	28	29.76	29.79	−.10	58.5	−1.5	69.8	47.3	82	40	2.45	−1.01	0.0
Medicine Hat, Alb	2,144	27.62	29.84	−.01	62.5	+0.5	75.1	49.9	88	41	0.84	−1.92	0.0
Calgary, Alb	3,428	26.42	29.96	+.12	54.0	−2.0	67.2	40.8	84	32	5.00	+2.55	0.0
Banff, Alb	4,521	25.40	29.94	+.10	49.5	−2.0	62.2	36.8	86	30	3.95	+0.62	0.6
Edmonton, Alb	2,150	27.64	29.90	+.06	56.4	−0.5	70.1	42.8	86	29	2.14	−0.72	0.0
Kamloops, B. C	1,262	28.68	29.95	+.08	65.1	+1.3	78.3	52.0	101	45	2.18	+0.76	0.0
Barkerville, B. C	4,180	25.68	29.98	+.11	48.8	−1.9	59.4	38.2	76	30	4.45	+0.97	0.0
Winnipeg, Man	760	29.07	29.89	.00	58.4	−3.8	71.0	45.9	84	32	1.39	−1.90	0.0

SEISMOLOGICAL REPORTS FOR JUNE, 1924

W. J. HUMPHREYS, Professor in Charge

[Weather Bureau, Washington, September 3, 1924]

TABLE 3.—*Late reports (instrumental)*

[Time used: Mean Greenwich, midnight to midnight. Nomenclature: International]

(For significance of symbols and description of stations, see the REVIEW for January, 1924)

ALASKA. *U. S. C. and G. S. Magnetic Observatory, Sitka.*

Date	Character	Phase	Time	Period T	Amplitude		Distance	Remarks
					A_E	A_N		
1924			H. m. s.	Sec.	μ	μ	Km.	
June 26	....	PR_E	1 58 04	10				
		ePR_N	1 58 01	10				
		e_E	2 03 08	11				
		e_N	2 03 34	12				
		e_E	2 05 24	20				
		e_N	2 08 14	11				
		SR^1_E	2 15 38					
		SR^1_N	2 15 32					
		e	2 29 47					
		L_E	2 34 53	40				
		L_N	2 35 14	40				
		M_E	2 16 15	20	*5,000			
		M_N	2 16 18	22		*2,500		
		F_E	4 11 ..					
		F_N	4 34 ..					
30	....	O	16 44 17				5,080	Changing paper on EW from 15^h 43^m to 16^h 21^m.
		P_N	15 52 50	4				
		S_N	15 59 37	12				
		SR_N	16 03 55	15				
		L_N	16 09 35	18				
		M_N	16 04 42	16		* 600		
		F_E	16 46 ..					
		F_N	16 42 ..					

ARIZONA. *U. S. C. and G. S. Magnetic Observatory, Tucson*

Date	Character	Phase	Time	Period T	A_E	A_N	Distance	Remarks
1924			H. m. s.	Sec.	μ	μ	Km.	
June 4	....	e_E	16 22 19					
		M_E	16 22 54		* 200			N not in good adjustment.
		F_E	16 40 ..					
18	....	eP_E	17 31 13	2				
		eP_N	17 31 33					
		L_E	17 31 52	5				
		M_E	17 32 20	5	* 400			
		C_E	17 35 ..	6				
		C_N	17 34 ..					
		F	17 44 ..					
26	....	ePR_E	1 57 22	24				One prominent long wave.
		SP_E	2 07 16	10				
		SP_N	2 07 30					
		SR_E	2 14 16	32				
		$L1_E$	2 30 50	30				
		L_N	2 34 16	20				
		$L2_E$	2 33 28	20				
		M_E	2 31 49	30	*1,400			
		C_E	2 40 00	17				
		C_N	2 39 ..					
		F_E	4 12 ..	16				
30	....	O	15 45 05				7,820	
		P_E	15 56 17	4				No definite long waves.
		S_E	16 05 28	5				
		F_E	17 00 ..					

* Indicates trace amplitude.

DISTRICT OF COLUMBIA. *Georgetown University, Washington*

Date	Character	Phase	Time	Period T	A_E	A_N	Distance	Remarks
1924			H. m. s.	Sec.	μ	μ	Km.	
May 1	....	eP_E	20 00 10					No distinct M_N.
		eP_N	20 00 14					
		S_E	20 05 12					Micros.
		S_N	20 05 02					
		eL_E	20 7 24					
		eL_N	20 7 18					
		M_E	20 13 33			*4,300		
		F	21 10 ..					
4	....	e_E	17 10 ..					
		e_N	17 10 ..					No distinct M.
		eL_E	17 22.4					Heavy micros.
		eL_N	17 22.4					
		L_E	17 30 27	9				
		L_N	17 21 21	11				
		F	17 55 ..					
6	....	L_E	17 08 ..					N–S does not show.
		L_E	17 15 23	21				Heavy micros.
		L_E	17 30 13	16				
		F	17 50 ..					

* Indicates trace amplitude.

DISTRICT OF COLUMBIA. *Georgetown University, Washington*—Con.

Date	Character	Phase	Time	Period T	Amplitude		Distance	Remarks
					A_E	A_N		
1924			H. m. s.	Sec.	μ	μ	Km.	
May 17	....	e_E	4 21 17					L waves of exceedingly small amplitude.
		L_E	4 43 28					
		F	4 56 ..					N–S does not show.
21	....	eP_E	10 18 54					
		eP_N	10 18 54					No records on the 18th.
		eS_E?	10 24 55					
		eL_E	10 28.4					Machines stopped to be oiled.
		eL_N	10 28.4					
		F	10 54 ..					
21	....	e_E	1 45 07					No other phases sure.
		e_N	1 44 30					
		F	1 55 ..					
28	....	eP_E	10 03 48					Heavy micros.
		eP_N	10 03 48					
		iS_E	10 13 36					No L or M apparent.
		eS_N	10 13 36					
		eL_E	10 26.5	11				
		F	10 55 ..					

HAWAII. *U. S. C. & G. S. Magnetic Observatory, Honolulu*

Date	Character	Phase	Time	Period T	A_E	A_N	Distance	Remarks
1924			H. m. s.	Sec.	μ	μ	Km.	
June 7	....	eP_E	19 37 05	4				
		eP_N	19 36 50	4				
		L_E	19 39 32	8				
		L_N	19 39 24	10				
		M_E	19 44 50	7	10			
		M_N	19 40 54	8		12		
		F	20 00 ..					
17	....	eP_E	21 19 55					
		eP_N	21 19 58					
		e_E	21 21 40	5				
		e_N	21 21 32					
		eL_E	21 23 04	7				
		eL_N	21 22 00	7				
		M_E	21 25 25	7	10			
		M_N	21 24 05	6		12		
		C_E	21 32 ..	6				
		C_N	21 27 ..	5				
		F	21 53 ..	6				
22	....	e_E	13 41 05					
		e_N	13 41 15					
		F_N	14 03 60					
		F_N	14 02 37					
26	....	O	1 37 30				9,620	N not operating.
		P_E	1 50 14	3				
		S_E	2 00 55	10				
		SP_E	2 01 50	20				
		SR_E	2 06 00	10				
		L_E	2 19 04	24				
		M_E	2 18 55	14	110			
		C_E	2 56 ..					
		F_E	5 51 ..					
26	....	e_E	11 42 ..					
		F_E	11 47 ..					
28	....	P_E	7 23 22	2				
		P_N	7 22 55	2				
		S_E	7 26 40	7				
		S_N	7 26 17	8				
		L_E	7 27 25	6				
		L_N	7 27 13	8				
		M_E	7 27 33	6	6			
		M_N	7 28 13	6		7		
		F_E	7 50 ..					
		F_N	7 47 ..					
30	....	O	15 45 09				4,460	
		P	15 53 09	2				
		e	15 55 28	8				
		S_E	15 59 05	12				
		S_N	15 58 59					
		SR_E	16 00 46	13				
		SR_N	16 00 51					
		L_E	16 04 53	18				
		L_N	16 04 49	15				
		M_E	16 07 57	20	80			
		M_N	16 14 51	10		40		
		C_E	16 18 ..					
		C_N	16 21 ..	8				
		F_E	18 27 ..					
		F_N	18 22 ..					

TABLE 3.—*Late reports (instrumental)*—Continued

NEW YORK. *Cornell University, Ithaca*

1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
Jan. 14		eS	21 14 ..					
		L	21 41 ..	28				
		L	21 52 ..	18				
		F	22 12 ..					
29		P	02 06 07					
		S	02 15 22					
		L	02 30 ..	28				
		L	02 36 ..	22				
		F	03 10 ..					
30		eP	20 59 45					Microseisms. S may begin at 21:04·23.
		eS	21 03 58					
		eL	21 06. 8					
		L	21 07. 6	16				
		F	21 26 ..					
Feb. 24		eL	06 05 ..					
		F	06 30 ..					
Mar. 4		P	10 14 26					
		S	10 19 50					
		L	10 22. 1					
		M	10 26 ..	16				
		F	11 48 ..					
		eS	11 55 45					
		eL	11 58. 3					
		L	11 59. 5	31				
		M	12 02 ..	16				
		L	13 04 ..					
		F	13 09 ..					
11		e?	10 47 45					
		e	10 48. 7					
		e	10 53 15					
		e	10 55 36					
		i	10 56 27					
		eL	10 58. 5	22				
		M	10 59. 5	15				
		F	11 34 ..					
15		L	11 13 ..					
		L	11 18 ..	18				
		F	11 47 ..					
22		L	13 24 ..	22				
		F	13 34 ..					
24		e	20 37 02					
		e	20 43. 9					
		L	20 47. 5	17				
		F	21 26 ..					
25		i	14 14 55					
		eS	14 19 ..					
		eL	14 24 ..	18				
		F	15 05 ..					
25		e	15 11 ..					
		e	15 15. 6					
		e	15 18 ..					
		L	15 21. 5	16				
		F	16 10 ..					
30		L	0 28 ..	22				Earlier phases lost in changing sheets
		F	1 15 ..					
Apr. 13		e	15 10. 5					
		F	15 18 ..					
14		e	16 41 44					
		e	16 42. 8					
		e	16 44 23					
		i	16 46 49					
		e	16 48 34					
		e	16 52 ..					
		e	16 59 ..	48				
		e	17 03. 6	35				
		eL	17 17 ..	50				
		F	21 55 ..					
21		eP?	20 07 30					
		i	20 08 11					
		S?	20 12 20					
		eL	20 14. 5					
		L	20 17. 5	40				
		F	20 54 ..					
May 1		eP	20 00 47					
		S	20 06 28					
		L	20 10. 5	30				
		F	21 11 ..					
6		e	16 29 50					
		e	16 46 ..					
		eL	17 00 ..					
		L	17 25 ..	16				
		F	17 48 ..					
21		L	01 45 ..	11				
		F	01 53 ..					

NEW YORK. *Cornell University, Ithaca*—Continued

1924			*H .m. s.*	*Sec.*	*μ*	*μ*	*Km.*
May 21		e	10 24 12				
		L	10 30. 6	20			
		F	10 45 ..				
27		eP	10 19 37				
		S	10 23 41				
		F	10 35 ..				
28		i	10 13 48				
		F	10 49 ..				
June 4		e	16 21 ..				
		eL	16 25 ..				
		L	16 28 ..	24			
		F	17 01 ..				
14		e	12 34 ..	12			
		F	12 39 ..				
18		eL	17 47 ..				
		F	17 56 ..				
26		eP	01 57 05				
		e	02 00 15				
		e	02 10 25				
		e	02 19 ..	35			
		e	02 24. 5	24			
		L	02 39 ..	40			
		L	02 45 ..	36			
		F	04 05 ..				
30		P	15 56 44				
		S	16 06 54				
		L	16 22 ..	28			
		L	16 29 ..	28			
		F	17 14 ..				

MARYLAND. *U. S. C. & G. S. Magnetic Observatory, Cheltenham*

1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*
June 26		PR1$_E$	1 57 15	4			
		PR1$_N$	1 57 11	3			
		PR2	2 00 38	10			
		e$_N$	2 06 49				
		SR2	2 18 19	32			
		eL$_E$	2 44 43	30			
		L$_N$	2 44 19	32			
		M$_E$1	2 47 03	24	*200		
		M$_E$2	2 52 43	20	*200		
		M$_N$1	2 45 19	32		*400	
		M$_N$2	2 56 19	16		*400	
		F$_E$	3 49 ..				
		F$_N$	3 55 ..				
30		O	15 44 45				9, 060
		P	15 57 02	3			
		S	16 07 16	3			
		F$_E$	16 40 ..				
		F$_N$	16 55 ..				

*Indicates trace amplitude.

PORTO RICO. *U. S. C. & G. S. Magnetic Observatory, Vieques*

1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
June 2		eP$_E$	11 26 29	2				
		eP$_N$	11 26 14	2				
		S	11 27 34	10				On Martinique.
		M$_E$	11 28 41		*200			
		M$_N$	11 28 28	8		*200		
		F$_E$	11 44 ..					
		F$_N$	11 39 ..					
19		e$_E$	2 17 10	·1				Vibrations very rapid. Less than 1 sec. probably.
		e$_N$	2 17 12	1				
		F$_E$	2 18 52		*100			
		F$_N$	2 18 40			*100		
28		ePR$_E$	2 00 03	8				N record incomplete.
		ePR$_N$	2 02 25					
		SR$_E$	2 16 25	24				
		SR$_N$	2 16 12	20				
		L$_E$	2 31 37					
		M$_E$	2 32 10		*800			
		F$_E$	3 51 ..	17				
30		e$_E$	16 10 34	5				Only a few long waves. Short waves barely perceptible.
		e$_N$	16 03 24	4				
		eL$_E$	16 42 38	20				

*Indicates trace amplitude.

TABLE 3.—*Late reports (instrumental)*—Continued

CANADA. *Meteorological Service of Canada, Toronto*

1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
June 4		L	3 04 15					Micros precede L.
W		F	Micros.					
		L	3 05 08					Small sinusiodal
N		L	3 06 00	15				waves.
		F	3 16 00					
4		e	16 16 08					
		L	16 21 30	15				Preceded by small
		L	16 26 08					micros.
N		L	(16 28 43)			5		
			(.. .. 49)	15				
		M	16 34 00	12		6		
		F	17 42 00					
		e	16 16 08					
		L?	16 21 23					
N		L	16 26 23					
		M	16 33 15	12	4			Micros going on.
		F	17 36 ..					
7		L	19 30 ..					
		L	?19 32 43	18				
W		L?	19 35 15					Heavy wind inter-
		F	Wind effect.					ferring.
		e	19 29 35					
		e	19 36 10					
N		L	19 51 38					Very small.
		L	19 55 50					Irregular.
		F	20 28 ..					
14		e	12 31 20					
		L	12 33 38	15				Small.
W		F	12 46 ..					
		L	12 33 15	15				
N		e	12 33 43	12	3			
		F	12 44 ..					
15		L	11 05 15	12				Movement at
W		F	11 16 ..					11 0 2 38
N		e	11 02 47					Very small.
		F	11 16 ..					
17		e	21 09 52					N-S component, not marked.
W		L	21 20 00	21				Small.
		?F	21 46 ..					
18		e?	17 42 38					Preceded by mi-
		e	17 46 08	5				cros.
W		L	17 46 52					
		M	17 49 15	12		6		
		M2	17 49 26	12				
		F	Micros.					
		e	17 45 23					
N		L	17 46 20		5			Sinusoidal to 17 48.
		F	Micros.					
22		L	14 14 08	8				Small sinusoidal
W		L	14 22 19					waves preceded
		F	Micros.					by micros.
N		L	?14 14					Very small.
		F	Micros.					
22		O	22 29 02					
		eP?	22 36 32	4				
W		iS	22 42 28	10			4, 160	
		L	22 48 45					
		M	22 50 to 22 50 23	23		11		
		F	Micros.					
		eP	22 36 30	4				Preceded by mi-
N		iS	22 42 30	6				cros.
		L	22 52 30					Small amplitude.
		F	Micros.					
24		e	?13 57 38					
W		L	14, 05, 51					Small.
		F						Paper changed at 14th 14 m.
		e	14, 03, 21					
N		eL	14 10 10	23				Small.
		F						Paper changed.
26		iP	1 56 58	5				
		i	2 00 58	13		54		
		i	2 07 02	10		24		Of the order of
		iS	2 10 23	10?				14,085 km.
W		iS	2 10 32	10				
		i	2 19 30	28				Well defined rec-
		L?	2 24 05					ord.
		M	2 51 35 / 40	22		280		
		F	7 02 00					
		iP	1 56 59	6				
		i	2 06 36	11				
		iS	2 10 21	?10				

9477—24†——4

CANADA. *Meteorological Service of Canada, Toronto*—Continued

1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
June 26		iS	2 10 23	?10				
N		i	2 12 28	10				
		i	2 19 32	?34				
		L	2 24 18					
		iL	2 24 27	23	135			
		M1	2 52 00	25				
		M2	2 52 20	19				
		M3	2 52 38	19				
		M4	2 52 57	19	113			
		F	7 02 00					
28		e	?23 04 18					N-S component, barely noticeable.
W		L	23 05 30					Very small.
		F	23 42 ..					
29		L?	?15 48 23					E-W component, record interfered with by N. and NW winds.
N		e	15 54 10					Very small.
		F	11 04 ..					
29		e	17 08 33					E-W component, winds interfered with record.
N		F	17 28					Very small.
29		e	18 54 05					Barely noticeable.
N		e	19 48 45					E-W component, winds interfered with record.
		F						
30		e	12 13 08					N-S component, nothing recorded.
W		e	12 15 30					Very small undu-
		F	12 46 ..					latory.
30		O	15 44 32					
		iP	15 56 33					
		iS	16 06 32					
		i	16 07 26	14				
W		i	16 19 00	15				
		L	16 21 55					
		M	16 30 02 / 15	18				
		M2	16 30 22	22		82	8, 780	
		F	19 30 ..					
		O	15 44 32					
		iP	15 56 34					
N		iS	16 06 34					
		e	16 19 00	15				
		L?	16 27 04				8, 790	
		M	16 29 42	15	18			
		F	19 06 ..					

CANADA. *Meteorological Service of Canada, Victoria*

1924			*H. m. s.*	*Sec.*	μ	μ	*Km.*	
May 1		O	19 54 17					
		P	20 02 47	8				
		S	20 09 31	10				
E		L	20 18 00	18				
		M	20 25 23	14		50	5, 030	
		F	22 20 11					
		O	19 54 17					
		P	20 02 47	8				
N		S	20 09 31	10				
		L	20 18 00	18				
		M	20 25 51	14	45		5, 030	
3		L	12 10 43	30				N-S component,
E		M	12 14 33	20		2		too small to meas-
		F	12 22 45					ure.
4		O	17 00 57					
		P	17 03 30	3				
		S	17 05 35	6				
E		L	17 09 35	12				
		M	17 22 45	10		7	1, 170	
		F	19 47 00					
		O	17 00 57					
		P	17 03 30	3				
		S	17 05 35	6				
N		L	17 09 35	12				
		M	17 22 35	10	6		1, 170	
		F	19 26 45					
5		P	6 27 56	6				
		L	6 37 28	12				
E		M	6 40 46	14		3		
		F	6 59 16					
		P	6 27 56	6				
N		M	6 43 36	12	2			
		F	6 55 16					

TABLE 3.—*Late reports (instrumental)*—Continued

CANADA.—*Meteorological Service of Canada, Victoria*—Continued

1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
May 6		P	3 14 40	8				
		L	3 36 38	20				
E		M	3 39 42	20		3		
		F	4 15 00					
		P	3 14 40	8				
N		L	3 37 20	20				
		M	3 39 18	20	3			
		F	4 08 00					
6		L	5 34 35	12				
E		M	5 36 12	10		1		
		F	5 39 30					
N		M	5 37 00	10	1			
6		P	6 28 41	5				
		L	6 32 56	10				
E		M	6 35 35	18		5		
		F	6 51 20					
		P	6 28 48	5				
N		L	6 32 55	8				
		M	6 35 42	18	4			
		F	6 52 00					
6		P	10 37 45	5				
		L	10 41 49	20				
E		M	10 44 33	20		7		
		F	10 55 00					
		P	10 37 48	5				
		L	10 41 50	12				
N		M	10 44 40	20	6			
		F	10 56 00					
6		O	16 10 26					
		P	16 23 02	5				
		S	16 33 36	10				
E		L	16 54 40	20				
		M	17 06 30	18		7	9,470	
		F	18 30 00					
6		O	16 10 21					
		P	16 23 02	6				
N		S	16 33 41	10				
		L	16 54 35	20				
		M	17 08 35	12	3		9,580	
		F	18 20 00					
8		P	6 00 06	5				
		L	6 19 59	18				
E		M	6 35 08	15		3		
		F	7 24 28					
		P	6 00 08	8				
		L	6 21 13	20				
N		M	6 39 18	16	2			
		F	6 47 28					
10		P	3 13 57	5				
		L	3 35 47	16				
E		M	3 59 25	16		2		
		F	4 30 45					
		P	3 13 57	8				
N		L	3 35 55	16				
		M	3 58 17	16	2			
		F	4 13 40					
12		L	14 09 54	20				
E		M	14 11 44	18		2		
		F	14 13 54					
		L	14 08 54	20				
N		M	14 12 04	15	2			
		F	14 16 12					
14		L	13 31 19	10				
		M	13 32 18	8		1		
E		F	13 34 03					
		L	13 31 19	10				
N		M	13 32 23	10	2			
		F	13 35 03					
17		P	4 10 06	8				
		L	4 25 24	18				
E		M	4 27 58	18		2		
		F	5 09 38					
		P	4 09 59	8				
		L	4 25 28	12				
N		M	4 27 55	18	3			
		F	4 52 18					
17		O	5 30 52					N-S component, too small to measure.
		P	5 40 48	8				
		S	5 48 48	12				
E		L	6 01 50	20				
		M	6 14 28	20		4	6,440	
		F	6 50 58					
May 21		O	1 37 12					
		P	1 38 03	5				
E		L	1 38 43	15				
		M	1 40 43	10		3	360	
		F	1 51 03					
		O	1 37 12					
		P	1 38 03	5				
N		L	1 38 43	13				
		M	1 40 18	10	2		360	
		F	1 51 18					
21		O	10 11 47					
		P	10 20 02	3				
		S	10 26 34	8				
		L	10 35 34	30				
E		M	10 37 30	22		4	4,810	
		F	10 57 52					
		P	10 21 14	4				
		L	10 35 34	30				
N		M	10 40 59	20	4			
		F	10 54 04					
24		P	2 39 25	6				
		L	2 56 13	14				
E		M	3 08 33	18		3		
		F	3 42 58					
		P	2 39 25	6				
		L	2 52 43	30				
N		M	2 56 33	16	2			
		F	3 34 43					
25		P	14 01 17	5				
		L	14 07 35	8				
E		M	14 07 40	10		2		
		F	14 14 17					
		P	14 01 17	6				
		L	14 07 27	8				
N		M	14 07 42	10	3			
		F	14 20 17					
27		L	3 08 27	20				N-S component, too small to measure.
E		M	3 15 44	18		3		
		F	3 30 17					
27		L	10 44 01	12				N-S too small to measure.
E		M	10 44 56	12		2		
		F	10 49 41					
28		O	9 57 55					
		P	10 01 00	6				
		S	10 03 30	10				
E		L	10 08 12	12				
		M	10 11 12	15		9	1,430	
		F	11 12 02					
		O	9 57 54					
		P	10 01 01	5				
N		S	10 03 32	10				
		L	10 08 13	12				
		M	10 11 02	15	9		1,440	
		F	11 04 02					
31								N-S component, too small to measure.
E		M	12 48 55	18		2		
June 4		O	16 09 52					
		P	16 17 38	8				
		S	16 23 48	10				
E		L	16 31 43	20				
		M	16 37 13	15		32	4,390	
		F	17 18 48					
		O	16 10 02					
		P	16 17 43	8				
		S	16 23 48	10				
N		L	16 31 38	20				
		M	16 38 28	12	11		4,310	
		F	17 17 38					
7		P	19 29 17	6				
		L	19 46 07	20				
E		M	19 47 29	20		5		
		F	20 27 07					
		P	19 29 11	8				
		L	19 45 47	20				
N		M	19 46 57	20	3			
		F	20 02 07					
14		L	12 31 10	20				
		M	12 32 48	18		2		
E		F	12 38 10					
		L	12 31 30	15				
N		M	12 32 50	10	1			
		F	12 39 10					

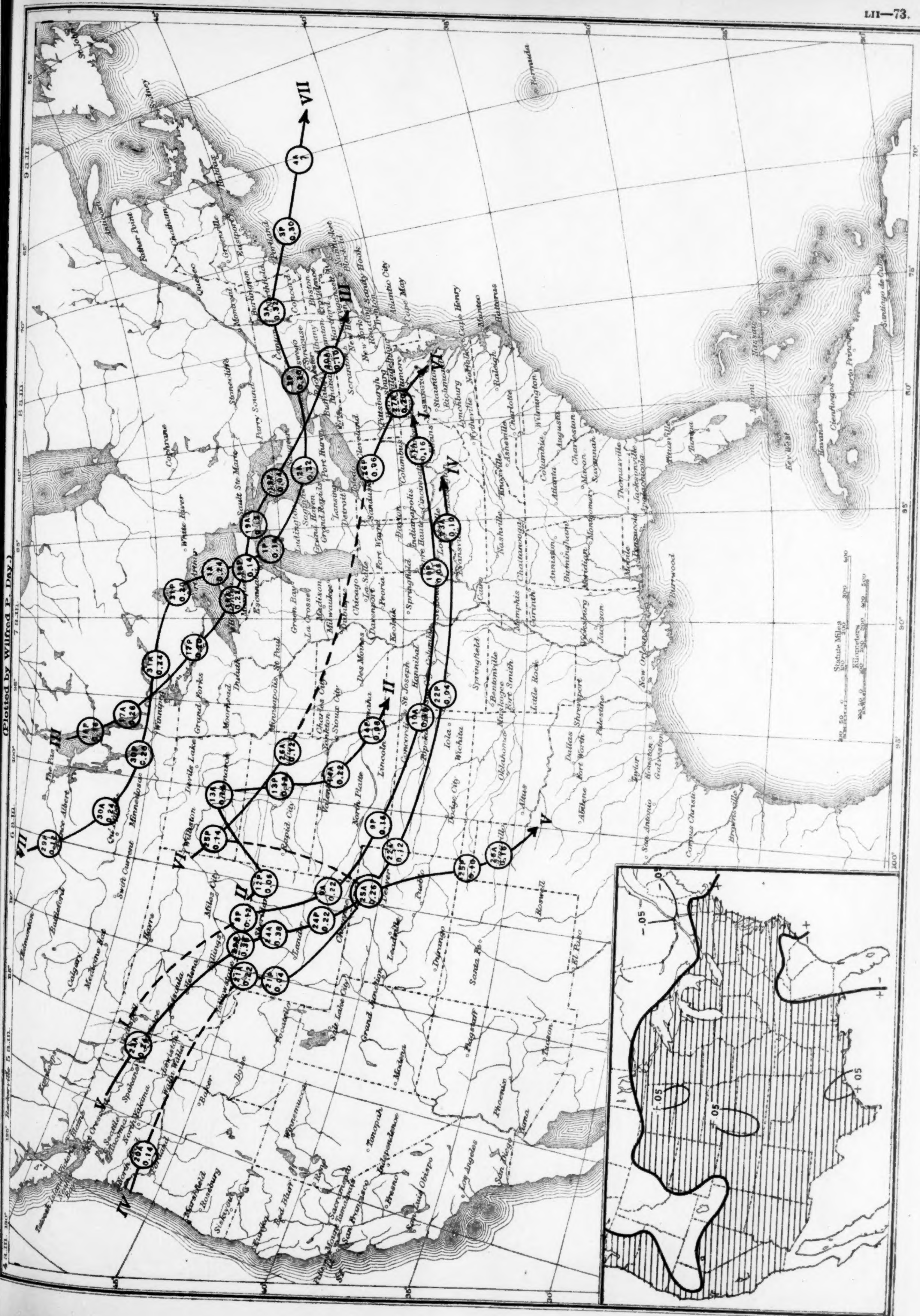
TABLE 3.—*Late reports* (*instrumental*)—Continued

CANADA.—*Meteorological Service of Canada, Victoria*—Continued

1924			H. m. s.	Sec.	μ	μ	Km.
June 17		P	21 11 16	8			
		L	21 18 43	18			
E		M	21 25 12	15		2	
		F	21 31 53				
		P	21 11 13	8			
N		L	21 20 39	20			
		m	21 24 41	15	3		
		F	21 35 03				
18		L	17 40 04	15			
E		M	17 40 49	12		4	
		F	17 58 04				
		L	17 40 19	12			
N		M	17 41 32	12	4		
		F	17 51 04				
19		P	1 50 24	5			
		L	1 50 54	20			
E		M	1 51 16	10		4	270
		F	1 56 59				
		L	1 51 04	18			
N		M	1 51 24	8	3		
		F	1 58 14				
22		P	13 44 19	8			
E		M	14 08 19	12		1	
		F	14 56 39				
		P	13 44 19	8			
N		M	14 03 54	10	1		
22		P	22 38 54	6			
		S	22 46 56	10			
E		L	22 59 41	20			
		M	(?)			1(?)	
		P	22 38 51	6			
N		S	22 46 46	10			
		L	22 56 08	15			
		M	(?)		(?)		

CANADA.—*Meteorological Service of Canada, Victoria*—Continued

1924			H. m. s.	Sec.	μ	μ	Km.	
June 24		L	14 19 02	25				
E		M	14 25 02	20		3		
		F	14 34 32					
N		M	14 24 32	16	2			
26		O	1 42 48					
		P	1 53 15?	8				P. S. and L. difficult to determine
			1 56 33					
E		S	2 08 10	12				
		L	2 33 07	35				
		M	2 37 18	25		375	10, 900	
		F	7 01 13					
		O	1 42 46					
		P?	1 53 15					
		P	1 56 31	6				
N		S	2 08 08	12				
		L	2 33 38	35				
		M	2 46 13	20	209		10, 900	
		F	7 00 58					
30		O	15 44 16					
		P	15 54 01	8				
		S	16 01 51	12				
E		L	16 12 11	25				
		M	16 12 43	25		80	6, 250	
		F	19 01 01					
		O	15 44 16					
		P	15 54 01	10				
N		S	16 01 51	12				
		L	16 09 43	25				
		M	16 10 29	25	52		6, 250	
		F	18 59 31					


(Plotted by Wilfred P. Day.)
I
II
III
IV
V
VI
VII
Statute Miles
Kilometers

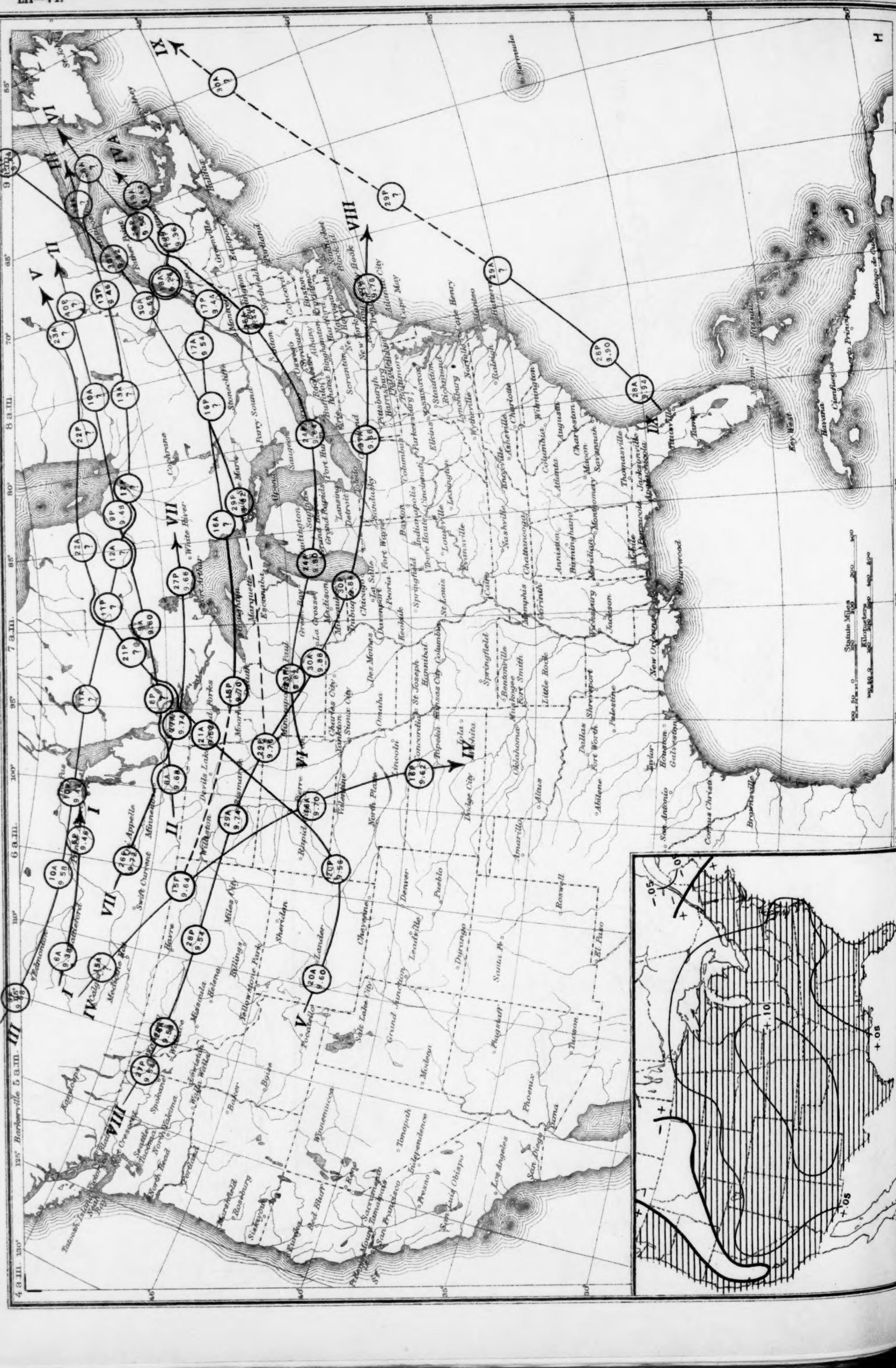


Chart II. Tracks of Centers of Cyclones, July, 1924. (Inset) Change in Mean Pressure from Preceding Month.
(Plotted by Wilfred P. Day.)

of the Mean Temperature from the Normal, July, 1924.

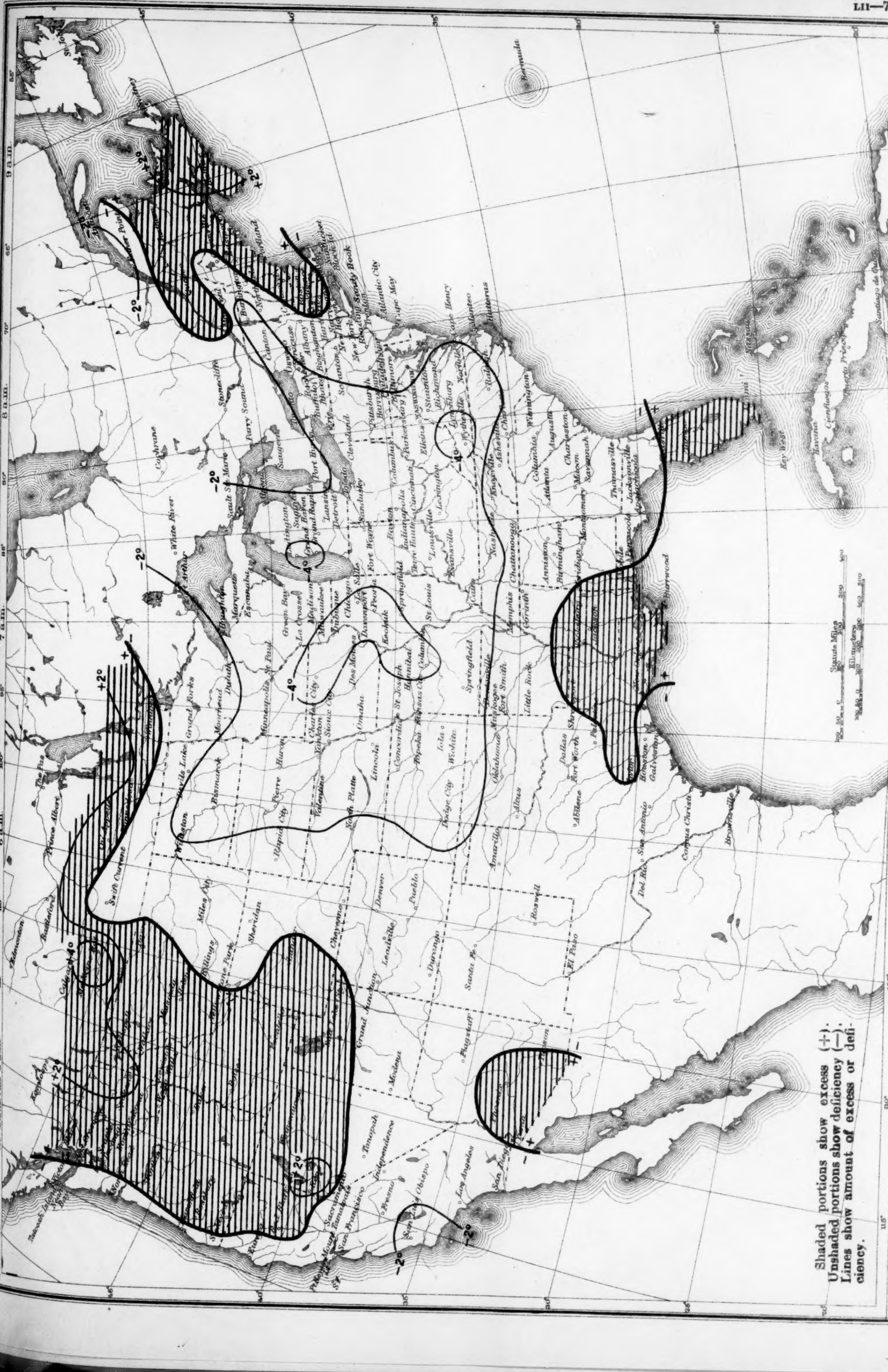


Chart IV. Total Precipitation, Inches, July, 1924. (Inset) Departure of Precipitation from Normal

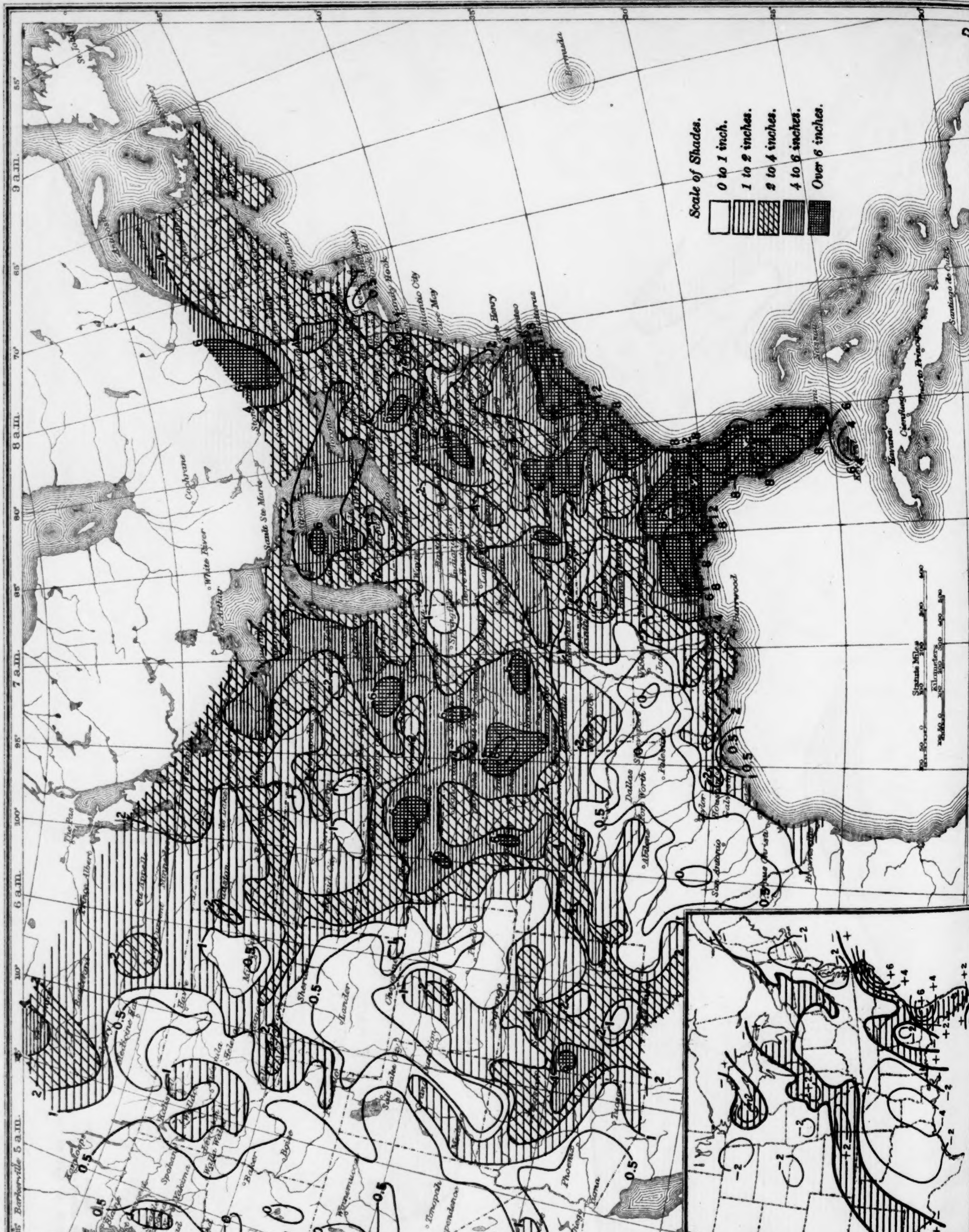


Chart V. Percentage of Clear Sky between Sunrise and Sunset, July, 1924

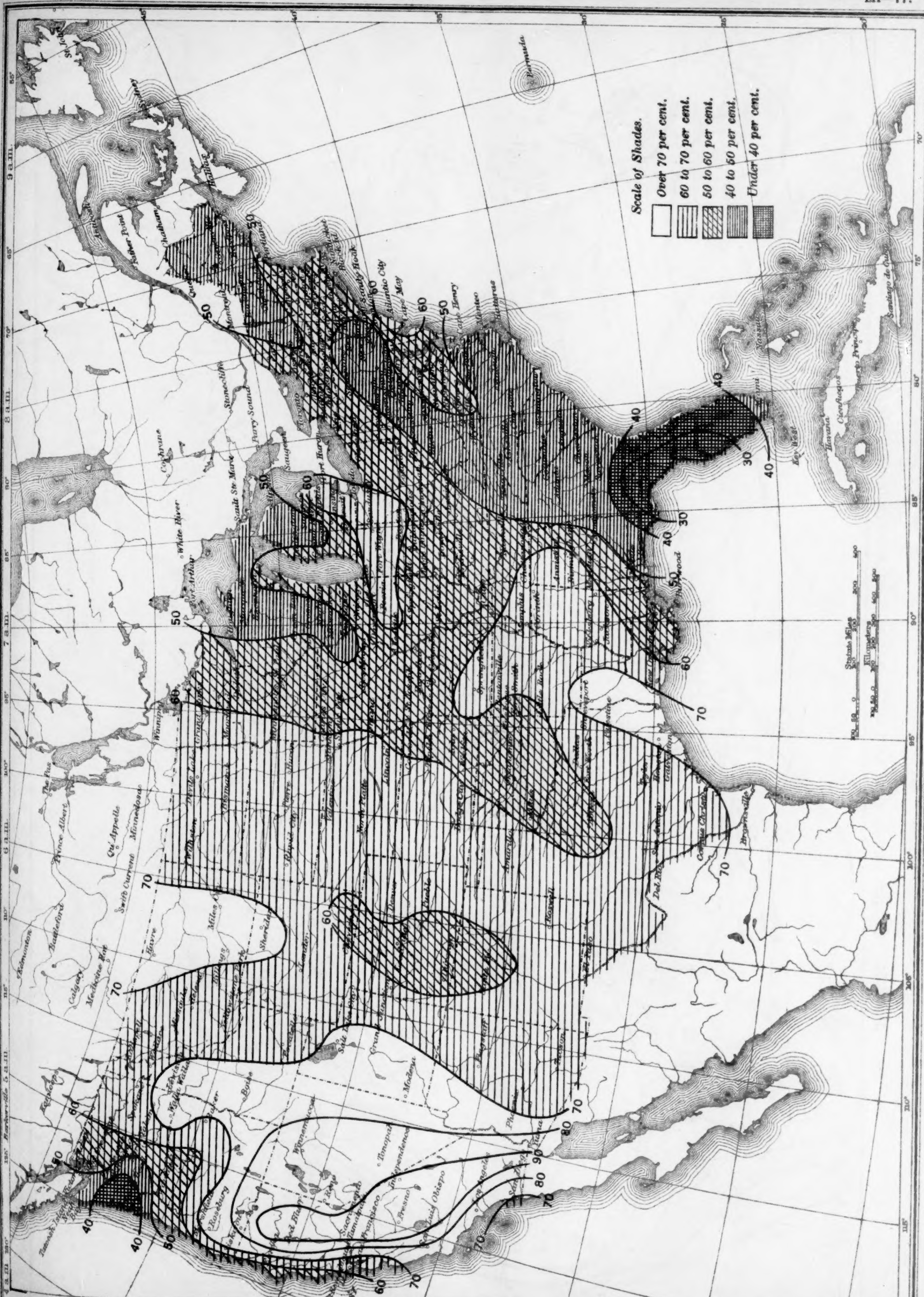
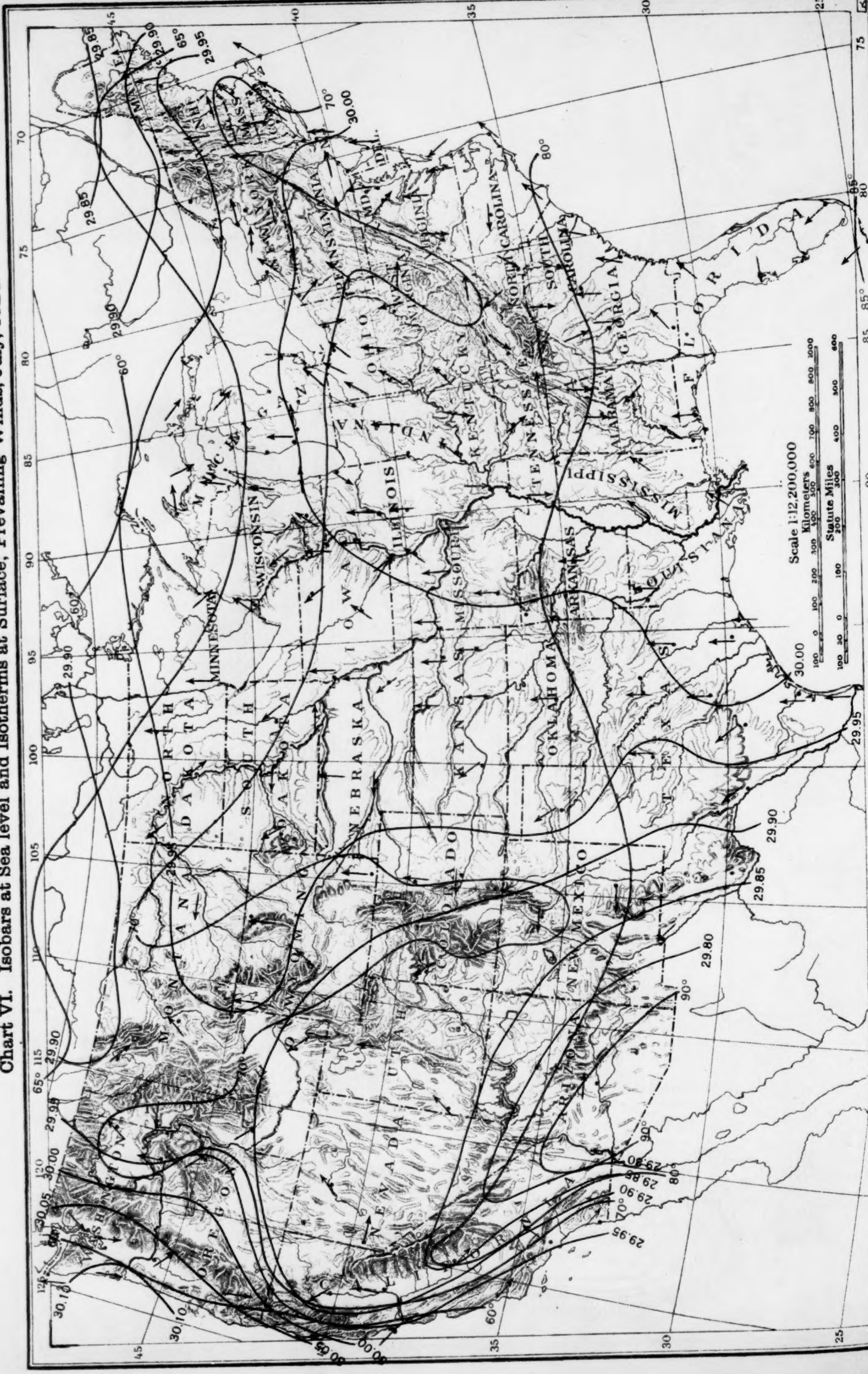


Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, July, 1924.



(Plotted by F. A. Young.)

(Plotted by F. A. Young.)

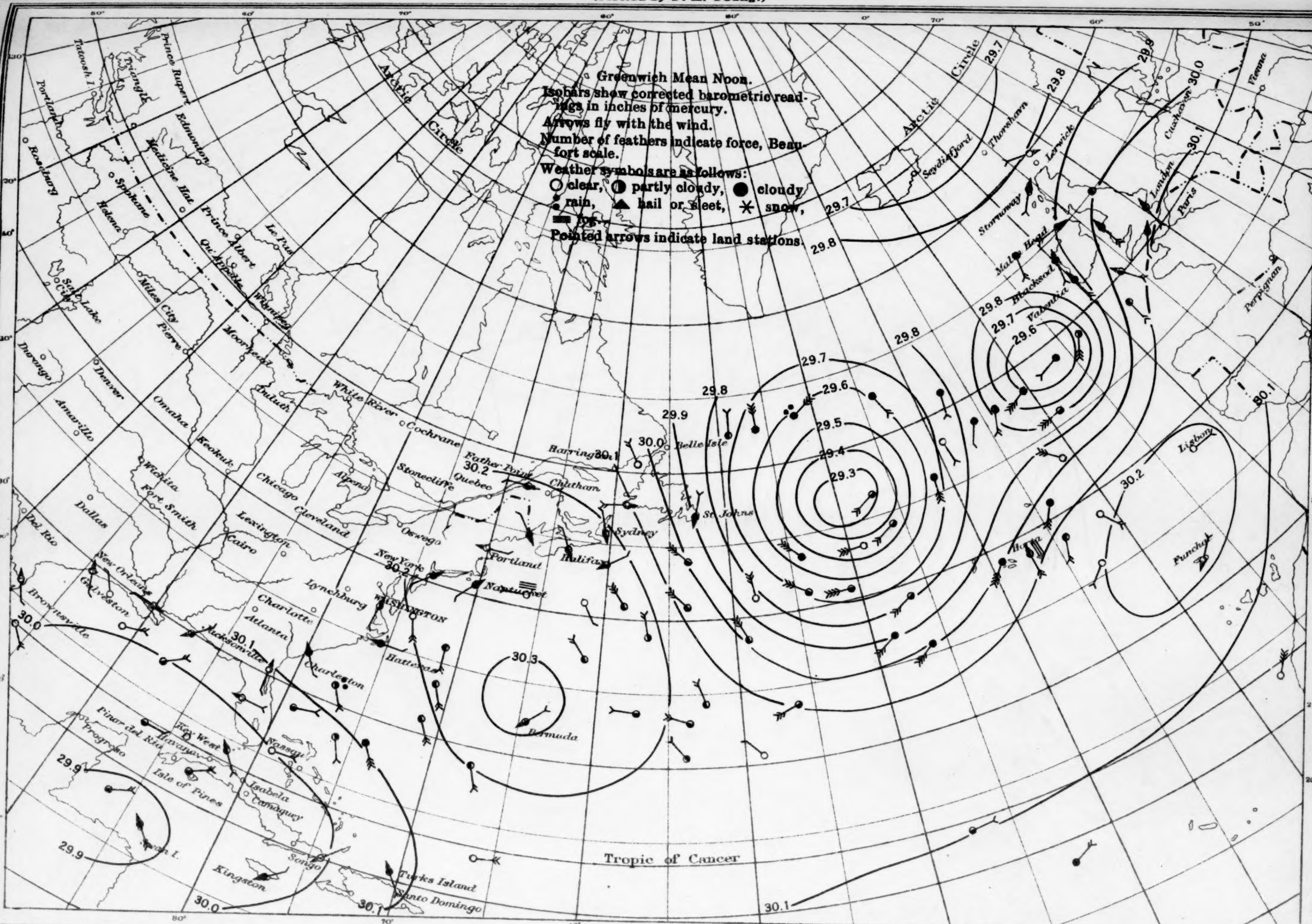
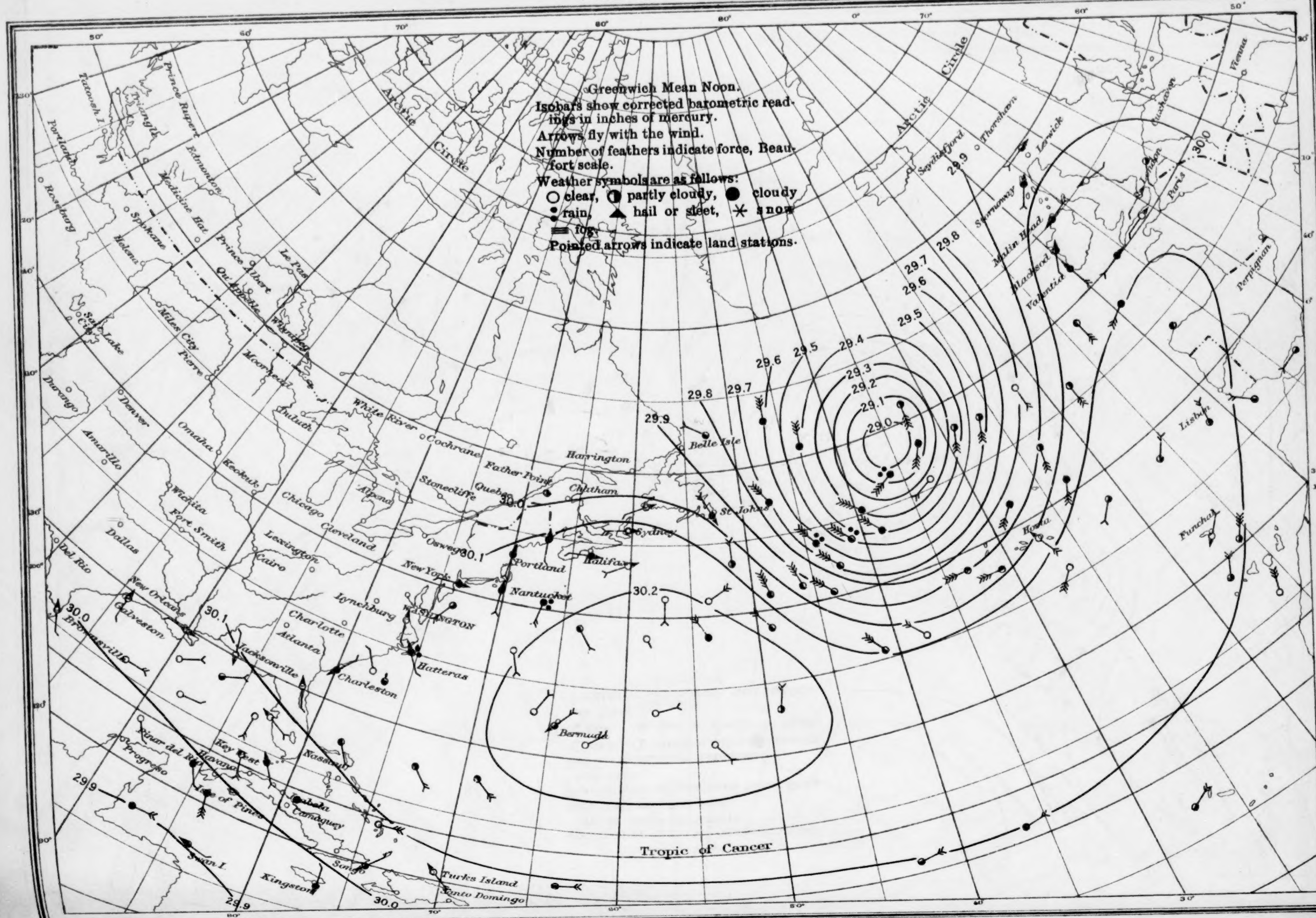


Chart IX. Weather Map of North Atlantic Ocean, July 9, 1924.

(Plotted by F. A. Young.)



(Plotted by F. A. Young.)

(Plotted by F. A. Young.)

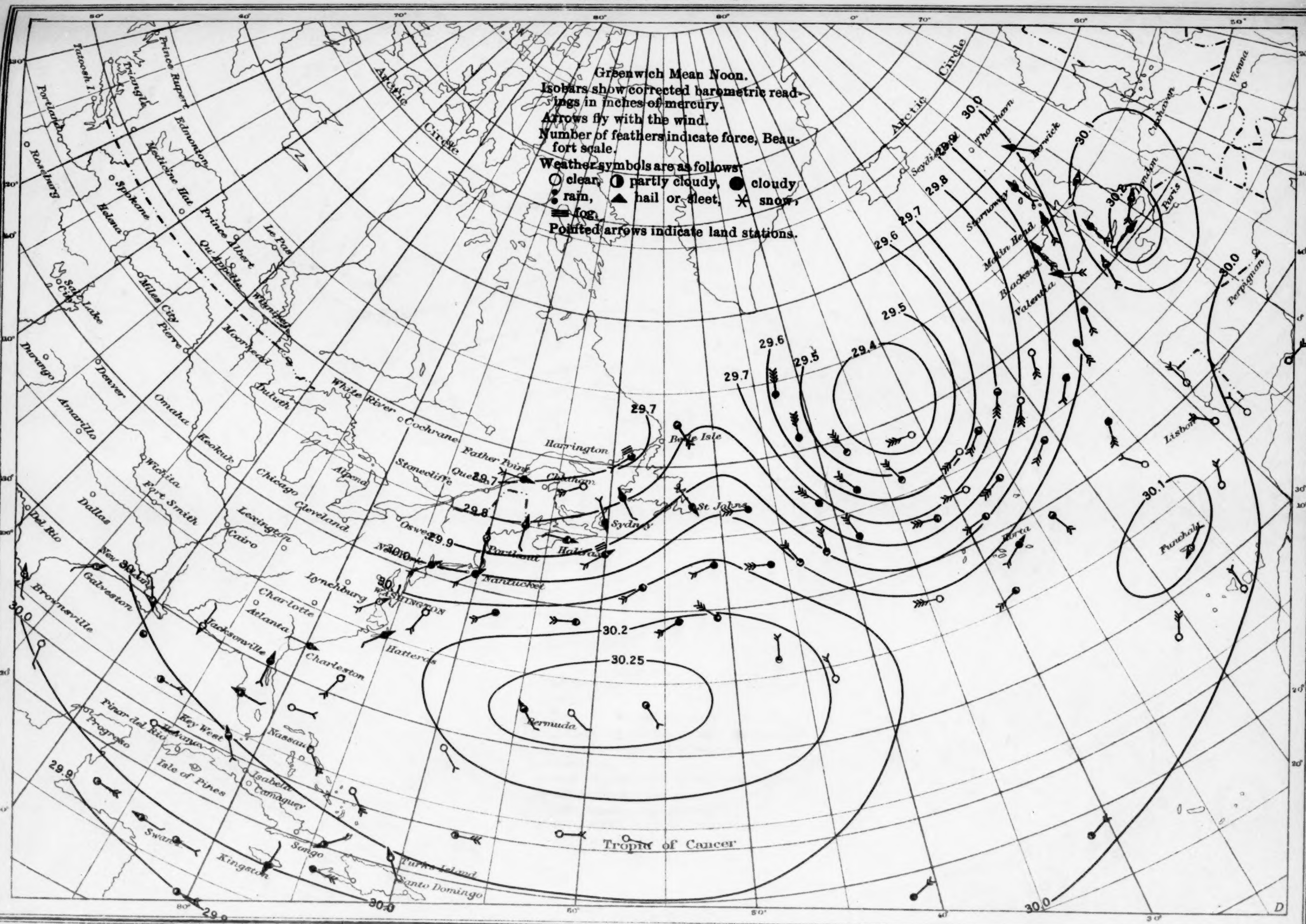


Chart XI. Weather Map of North Atlantic Ocean, July 11, 1924.
(Plotted by F. A. Young.)